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TM 9-1786A

TM

1944

WAR DEPARTMENT TECHNICAL MANUAL

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ORDNANCE MAINTENANCE

**ENGINE, ENGINE ACCESSORIES,
CLUTCH GROUP, AND PROPELLER
SHAFT FOR 13-TON, HIGH-SPEED**

TRACTOR M5

WAR DEPARTMENT

15 JANUARY 1944

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Washington 25, D. C., 15 JANUARY 1944

TM 9-1786A, Ordnance Maintenance, Engine, Engine Accessories, Clutch Group, and Propeller Shaft, for 13-ton, High-speed Tractor M5, is published for the information and guidance of all concerned.

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(For explanation of symbols, see FM 21-6.)

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CHAPTER 1

INTRODUCTION

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1. SCOPE.

a. The instructions contained in this manual are for the information and guidance of personnel charged with the maintenance and repair of the Continental model R6572 engine, cooling system, fuel system, clutch group, and propeller shaft for the 13-ton, high-speed tractor M5. These instructions are supplementary to field and technical manuals prepared for the using arms. This manual does not contain information which is intended primarily for the using arms, since such information is available to ordnance maintenance personnel in 100-series TM 9-786.

b. This manual contains a description of, and procedure for, disassembly, inspection, and repair of the engine, cooling system, fuel system, clutch group, and propeller shaft for the 13-ton, high-speed tractor M5.

c. TM 9-786 contains vehicle operating instructions and maintenance instructions.

d. TM 9-1786B contains maintenance and repair information for the transmission, differential, electrical system, air system, suspension, and body.

e. TM 9-1825A contains maintenance and repair information for the electrical equipment.

f. TM 9-1826C contains maintenance and repair information for the carburetors.

g. TM 9-1828A contains maintenance and repair information for the fuel pump.

h. TM 9-1829A contains maintenance and repair information for the speedometer and tachometer.

2. FSMWO AND MAJOR UNIT ASSEMBLY
REPLACEMENT RECORD.

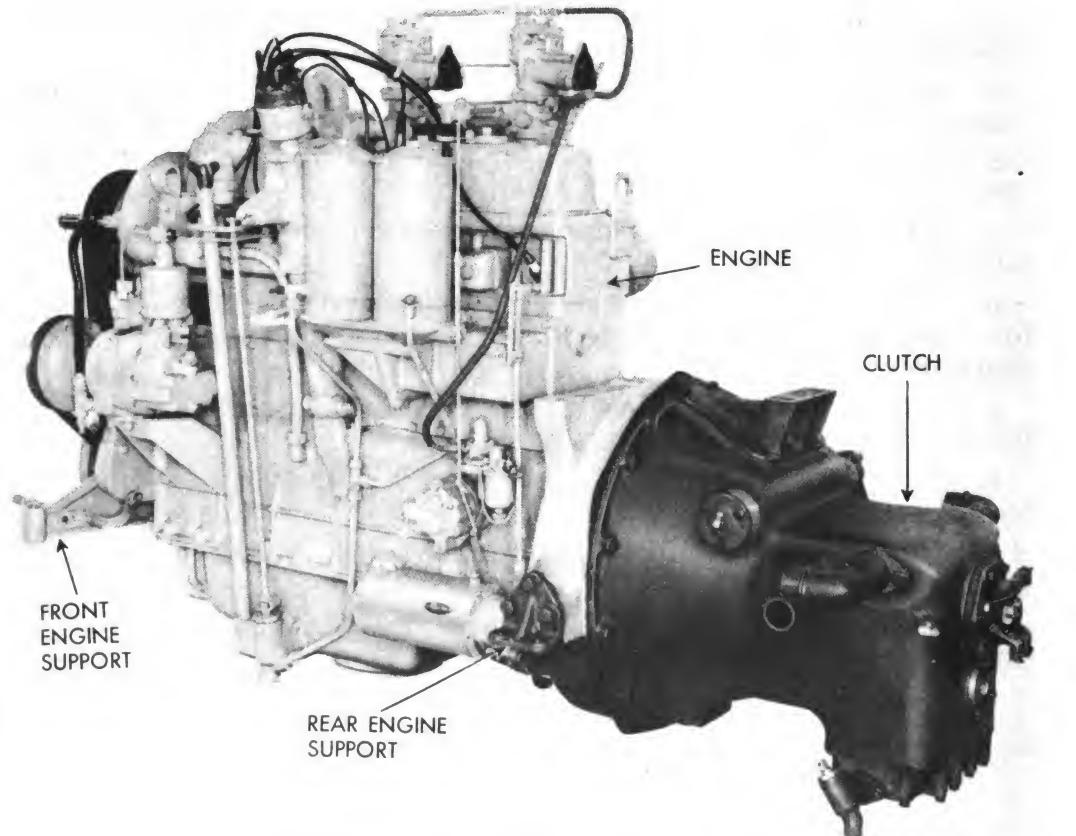
a. **Description.** Every vehicle is supplied with a copy of AGO Form No. 478 which provides a means of keeping a record of each FSMWO completed or major unit assembly replaced. This form includes spaces for the vehicle name and U. S. A. Registration Number, instructions for use, and information pertinent to the work accomplished. It is very important that the form be used as directed, and that it remain with the vehicle until the vehicle is removed from service.

b. **Instructions for Use.** Personnel performing modifications or major unit assembly replacements must record clearly on the form a description of the work completed, and must initial the form

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in the columns provided. When each modification is completed, record the date, hours and/or mileage, and FSMWO number. When major unit assemblies, such as engines, transmissions, and transfer cases are replaced, record the date, hours and/or mileage, and nomenclature of the unit assembly. Minor repairs and minor parts and accessory replacements need not be recorded.

c. Early Modifications. Upon receipt by a third or fourth echelon repair facility of a vehicle for modification or repair, maintenance personnel will record the FSMWO numbers of modifications applied prior to the date of AGO Form No. 478.



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Figure 1 — Left Side of Engine With Clutch

CHAPTER 2

ENGINE MODEL R6572

Section I

DESCRIPTION AND DATA

	Paragraph
Description and operation	3
Data	4

3. DESCRIPTION AND OPERATION.

a. **Description.** The engine used in the 13-ton, high-speed tractor M5 is a Continental Model R6572. It is a 6-cylinder in-line, 4-cycle, valve-in-head, liquid-cooled gasoline engine of conventional design. The cylinders and crankcase are cast in one unit, and are both referred to as the crankcase. The engine is equipped with two downdraft carburetors and one distributor.

b. Identification.

(1) **SERIAL NUMBER.** The engines are numbered consecutively from 1,000 up. The number is stamped on a name plate located on the front left side of the crankcase.

(2) **REFERENCE.** The cylinders are numbered from front to rear; No. 1 cylinder is the one nearest the fan end of the engine. The front of the engine (fan end) is installed toward the rear of the vehicle. However, even though it is installed this way, the fan end is always referred to as the front, and the flywheel end as the rear, to conform with automotive practice. The carburetor side is referred to as the right side of the engine, and the distributor side as the left side of the engine.

c. **Accessories.** The two downdraft carburetors, intake and exhaust manifolds, carburetor shut-off solenoid, coolant outlet header, and generator are mounted on the right side of the engine (fig. 2). The fuel pump, air compressor, ignition coil, spark plugs, starter, distributor, governor, two oil filters, oil scavenger pump, oil cooler, oil level gage rod, crankcase breather air cleaner, and coolant inlet header are mounted on the left side of engine (fig. 3). Removal of all accessories, except the governor, is covered in TM 9-786. Maintenance and repair of accessories is covered in other chapters of this manual and in other TM's. Refer to chapter 1, paragraph 1, e, f, g, and h for the number of manuals and the accessories they cover.

d. **Operation.** The model R6572 engine is of the internal-combustion type, using gasoline as fuel, and designed to operate on the four-stroke cycle or "four-cycle" principle. This means that four strokes of the piston are required to complete a cycle of operation. Starting with the intake stroke, the piston moves

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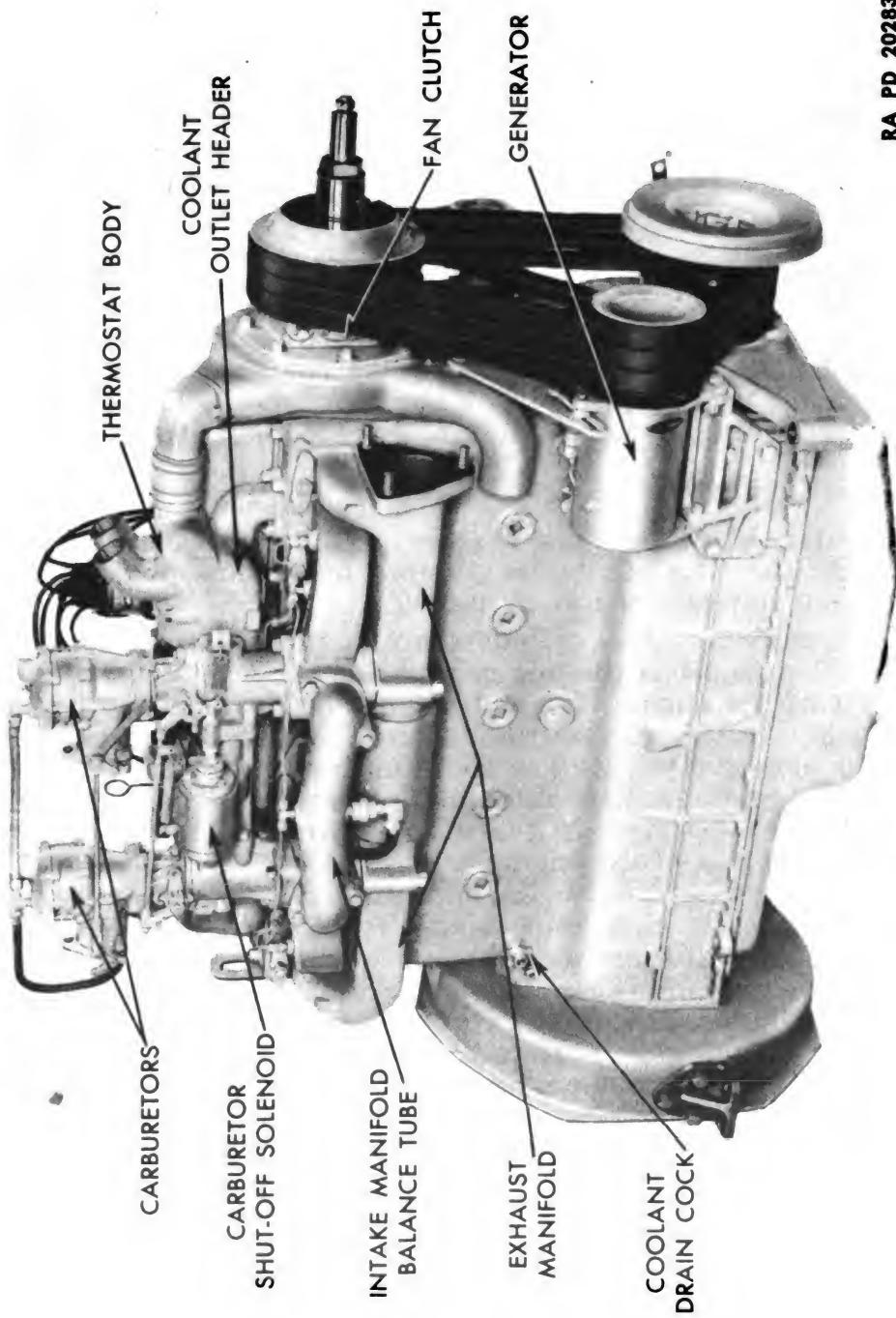


Figure 2 — Right Side of Engine

DESCRIPTION AND DATA

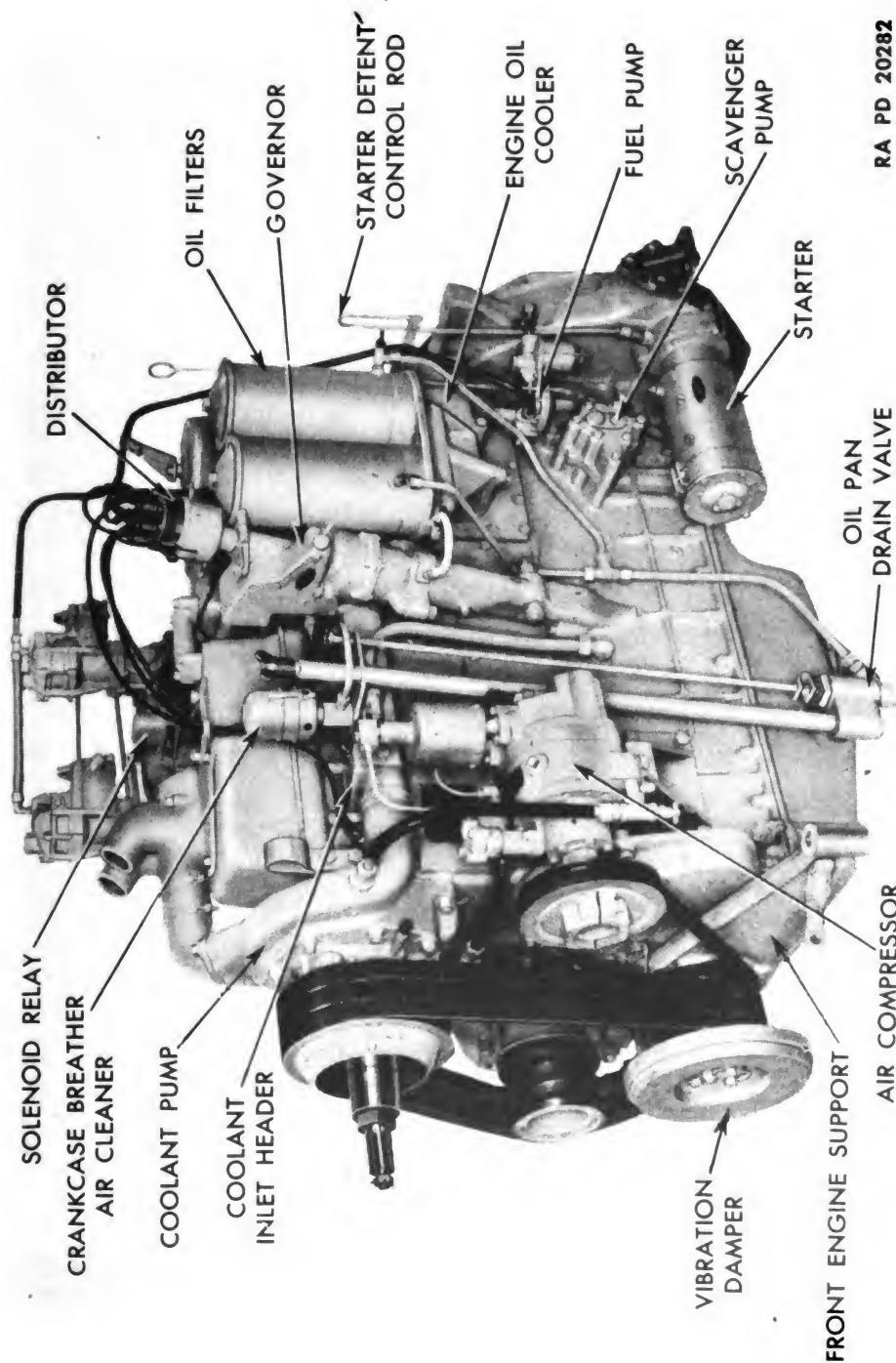


Figure 3 — Left Side of Engine

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AND PROPELLER SHAFT FOR 13-TON, HIGH-SPEED TRACTOR M5**

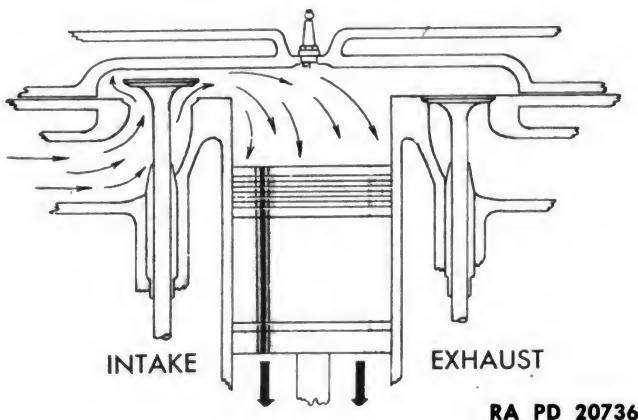


Figure 4 — Intake Stroke

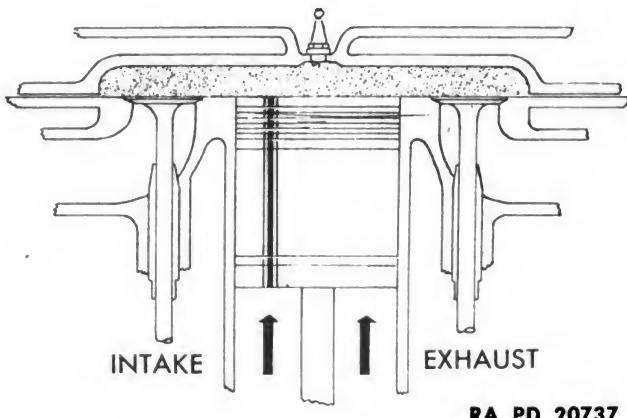
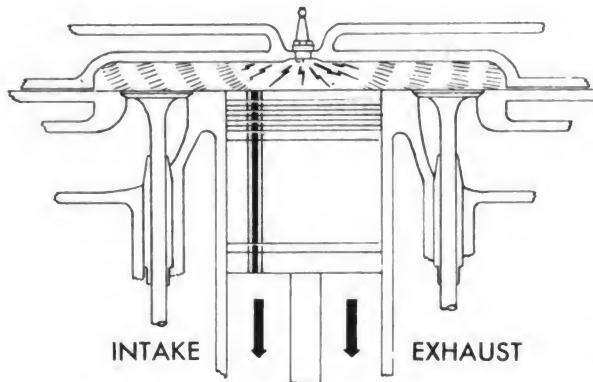


Figure 5 — Compression Stroke

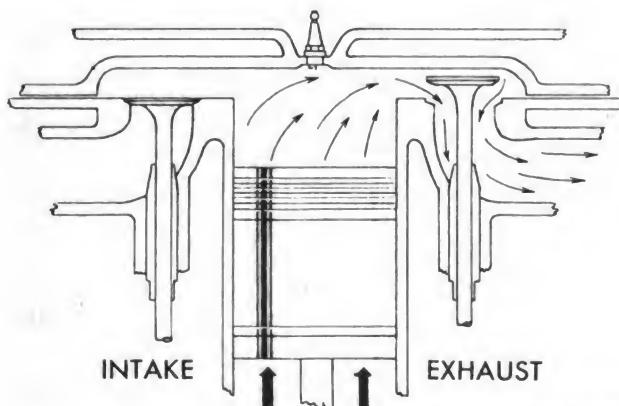
down with the intake valve open (fig. 4). The downward movement of the piston creates a partial vacuum in the cylinder and intake manifold, and thus draws in a mixture of air and gasoline vapor from the carburetor. At the bottom of the intake stroke, the intake valve closes. The piston then moves up with both intake and exhaust valves closed (fig. 5). The upward movement of the piston compresses the mixture into a very small space in the head of the engine. At the top of the compression stroke, a spark occurs at the spark plug (fig. 6) igniting the mixture, causing

DESCRIPTION AND DATA



RA PD 20738

Figure 6 — Power Stroke



RA PD 20739

Figure 7 — Exhaust Stroke

it to expand. The expansion of the air and gasoline vapor mixture forces the piston down on the power stroke. The power is transmitted through the connecting rod to the crankshaft. When the piston reaches the bottom of the power stroke, the exhaust valve opens. The piston then moves up, forcing the burned gasses out through the open exhaust valve (fig. 7) into the exhaust manifold. From there the burned gasses are expelled through the muffler. The above cycle of operations is repeated in each cylinder in accordance with firing order 1-5-3-6-2-4.

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4. DATA.

a. General.

Make	Continental
Model	R6572
Type	valve-in-head, cylinders-in-line
Cooling	liquid
Number of cylinders	6
Bore	4 $\frac{3}{4}$ in.
Stroke	5 $\frac{3}{8}$ in.
Displacement	571.7 cu in.
Firing order (from fan end)	1-5-3-6-2-4
Serial No.	1,000 up
Serial No. location	left side of crankcase
Weight with accessories (less clutch)	2026 lb
Weight bare	1500 lb
Horsepower at 2,900 rpm (stripped engine)	235
Maximum torque (1,600 rpm)	490 ft lb
S.A.E. rated horsepower	54.2
Compression ratio	6.5 to 1
Crankcase capacity	17 qt
Oil filter capacity	5 qt
Total capacity	22 qt
Direction of rotation (from flywheel end)	
Camshaft	clockwise
Crankshaft	counterclockwise
Starter	clockwise
Generator	counterclockwise
Coolant pump	counterclockwise
Air compressor	counterclockwise
Ratio of accessory drives to crankshaft	
Starter	12.15 to 1
Generator	1.14 to 1
Coolant pump	0.7 to 1
Oil pump	0.5 to 1
Air compressor (with new belt)	1 to 1
Air compressor (with worn belt)	0.86 to 1
Oil pressure (with hot oil)	
2,400 rpm	50 to 55 lb
500 rpm	15 lb min.
Type of suspension	3 point

DESCRIPTION AND DATA

Connecting rods numbered	No. 1 at fan end
Installation of rods	From top of crankcase
Oil drain valve	Left side of oil pan
Oil drain valve handle	Left side
Oil level gage rod	Left side
Oil filler location	Engines 1,001 to 1,542 top of rear cylinder head cover. Engines 1,543 and up top of front cylinder head cover.
Oil pressure regulator	In oil pump
Coolant drain location	Left side at front and rear
Crated weight	2,594 lb
Width	37 $\frac{3}{4}$ in.
Height	56 $\frac{1}{2}$ in.
Length	65 in.

b. Timing Gears.

Type	Helical
Pitch	10 degrees
Width	1 $\frac{3}{8}$ in.

c. Intake Valve.

Make	Toledo Steel Products Co.
Material	No. 1 Silchrome
Overall length	6 $\frac{33}{64}$ in.
Stem diameter	0.4969 to 0.4977 in.
Head diameter	2 $\frac{9}{64}$ in.
Seat angle	30 degrees
Location	In cylinder head
Number in engine	6
Opens, before top dead center	17 degrees
Closes, after bottom dead center	57 degrees
Intake period	254 degrees

d. Exhaust Valve.

Make	Toledo Steel Products Co.
Material	
Head	T.P.A. Steel
Stem	SAE 3140 (chrome nickel)
	(Stellite seat and Bright Ray coated head)
Over-all length	6 $\frac{37}{64}$ in.
Stem diameter	0.494 to 0.495 in.
Head diameter	1 $\frac{57}{64}$ in.
Seat angle	45 degrees

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Location	In cylinder head
Number in engine	6
Opens, before bottom dead center	59 degrees
Closes, after top dead center	15 degrees
Exhaust period	254 degrees

e. Valve Stem Guides (Intake and Exhaust).

Length	3 $\frac{3}{16}$ in.
Outside diameter	0.8755 to 0.8765 in.
Inside diameter	0.4985 to 0.4990 in.

f. Valve Tappet Guides.

Length	2 $\frac{5}{8}$ in.
Diameter of pilot	1.4350 to 1.4365 in.
Inside diameter	0.6890 to 0.6101 in.

g. Accessories.

Generator	Delco-Remy 1105906
Starter	Delco-Remy 1109123
Distributor	Delco-Remy 1110170
Coil	Delco-Remy 1115253
Spark Plugs	Champion 5 Commercial
Air Compressor	Wagner type KCF No. S-AF-1202
Carburetor (2)	Zenith Model No. 29-14- Parts No. 0-10087 0-10088
Oil Filter (2)	Purolator No. 25788
Thermostat (4)	Bishop & Babcock No. 65805
Governor	Pierce No. MA-1489
Fuel Pump	A. C. No. 1538259

CHAPTER 2 (Cont'd)

ENGINE MODEL R6572 (Cont'd)

Section II

DISASSEMBLY INTO SUBASSEMBLIES

	Paragraph
Preliminary instructions.....	5.
Disassembly.....	6

5. PRELIMINARY INSTRUCTIONS.

a. Mount Engine On Stand. Before mounting engine on stand, engine clutch and clutch gear reduction unit must be removed as described in paragraph 90 a (18) to (21). Mount engine on revolving stand. Secure front engine support and rear supports to brackets on stand with six cap screws and nuts (fig. 8).

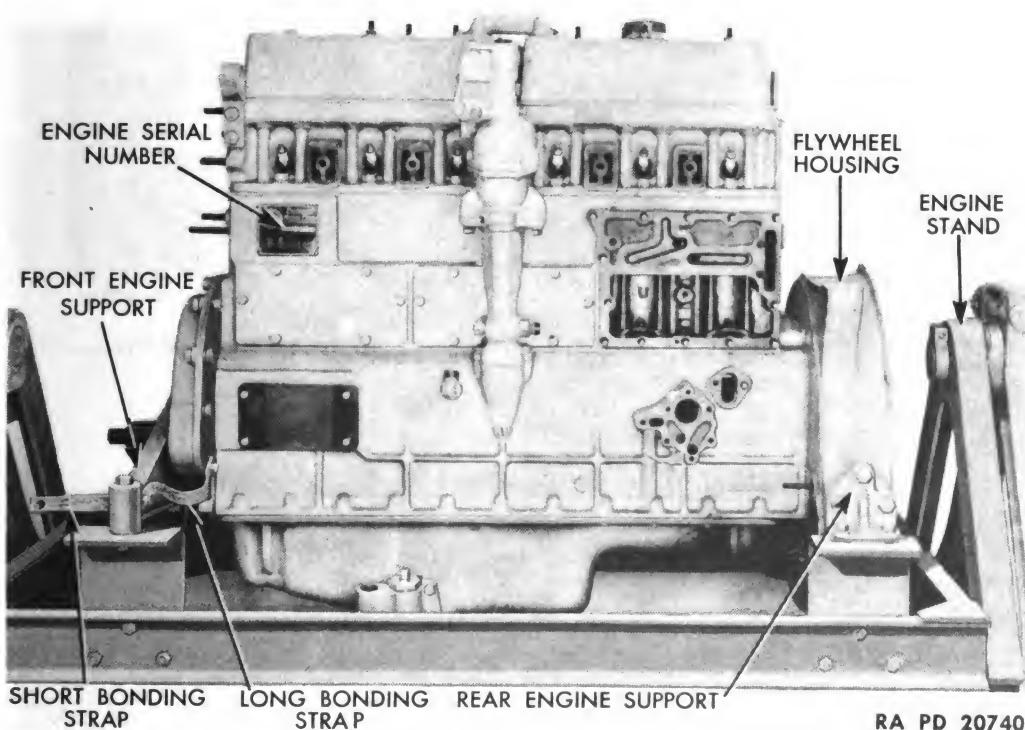


Figure 8 — Engine Without Accessories Mounted on Stand

b. Clean Exterior of Engine. Thoroughly clean exterior of engine with dry-cleaning solvent or steam. Blow off with compressed air after cleaning with dry-cleaning solvent.

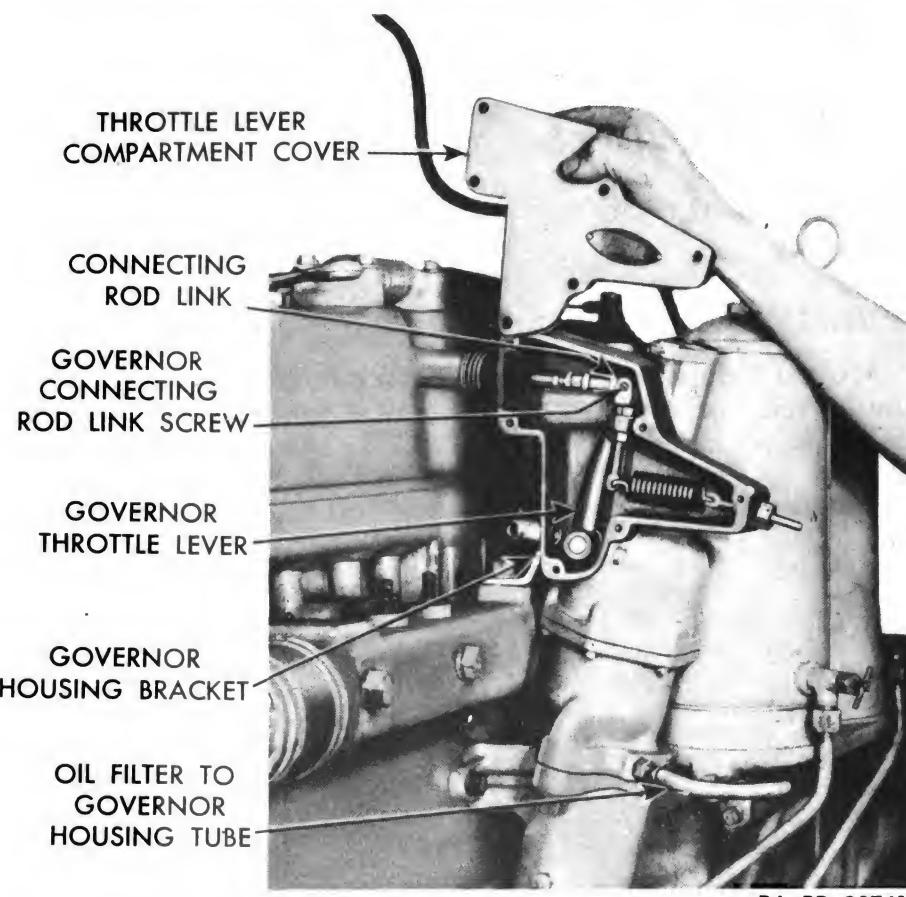
ORDNANCE MAINTENANCE — ENGINE, ENGINE ACCESSORIES, CLUTCH GROUP,
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Figure 9 — Removing Governor Throttle Lever Compartment Cover

c. Remove Accessories.

(1) Refer to TM 9-786 for removal of air compressor, generator, starter, carburetors, spark plugs, distributor, ignition coil, carburetor shut-off solenoid, fan belts, oil cooler, oil filters, crankcase breather air cleaner, oil level gage rod, fuel pump, scavenger oil pump, coolant pump, and coolant inlet and outlet headers.

(2) REMOVE GOVERNOR. Cut wire, and remove governor seal. Remove six screws and lock washers holding throttle lever compartment cover to governor body. Lift off cover (fig. 9). Remove connecting rod link screw from governor throttle lever, and disconnect connecting rod link from throttle lever (fig. 9). Remove two nuts and lock washers holding governor assembly to drive shaft housing. Lift off governor (fig. 10). Remove governor connecting rod tube. Remove four screws and lock washers holding governor drive shaft housing to crankcase. Lift off housing (fig. 11). Remove six nuts and lock washers holding governor throttle body assembly to intake manifold. Lift body assembly off studs (fig. 12).

DISASSEMBLY INTO SUBASSEMBLIES

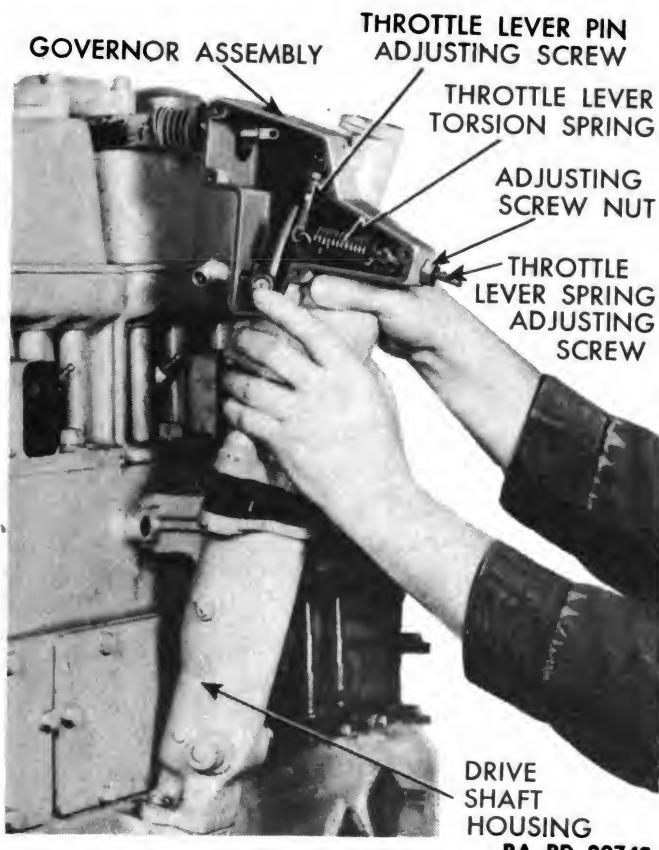
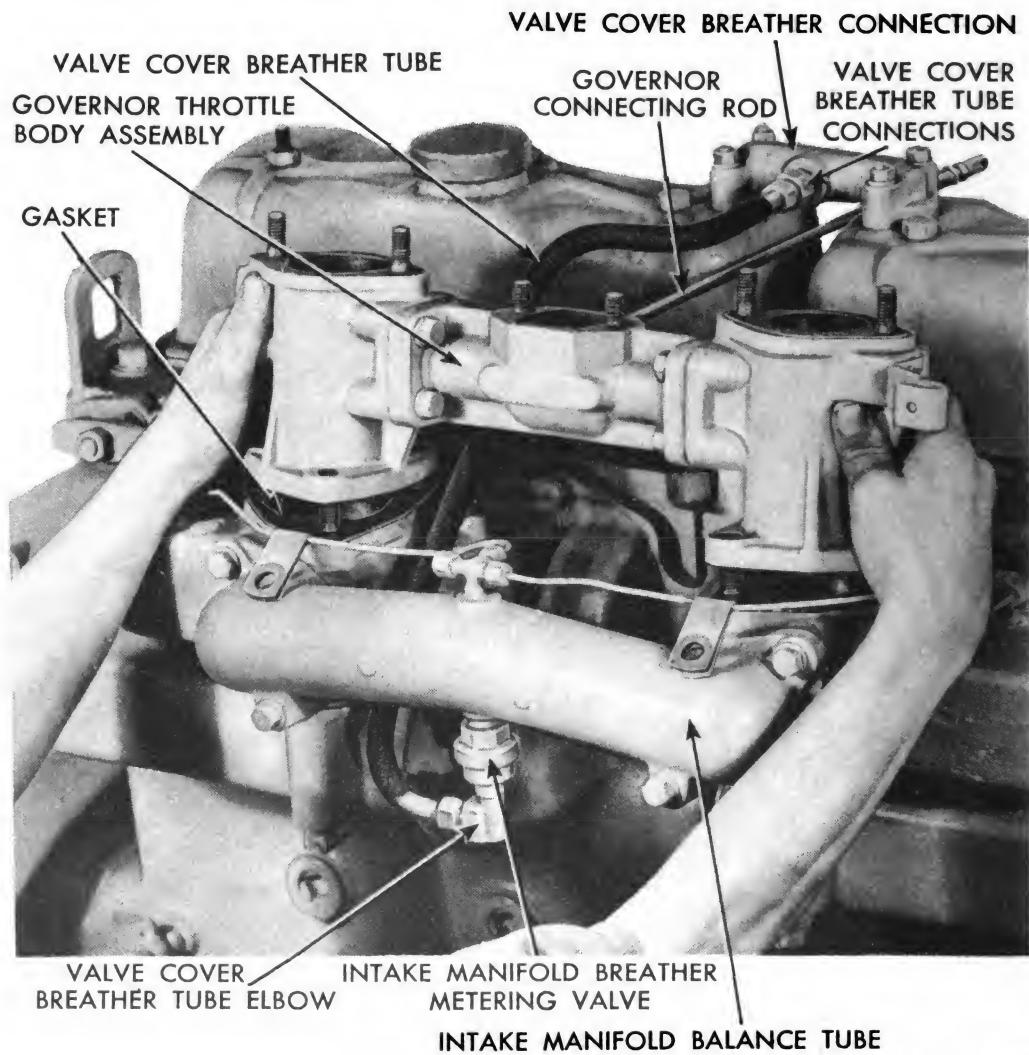


Figure 10 — Removing Governor Assembly



Figure 11 — Removing Governor Drive Shaft Housing

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RA PD 20744

Figure 12 — Removing Governor Throttle Body Assembly

6. DISASSEMBLY.

- a. **Drain Oil From Crankcase.** Remove drain plug from bottom of oil pan, and drain oil.
- b. **Remove Cylinder Head Valve Cover Breather Tube.** Loosen two nuts connecting breather tube to valve cover breather connection and to elbow at metering valve, and remove tube (fig. 12).
- c. **Remove Intake and Exhaust Manifold with Primer Tubes.** Remove 15 nuts, 4 plain washers, and 11 crabs holding the intake and exhaust manifold assembly to the two cylinder heads. Lift off the manifold assembly and two gaskets (fig. 13).
- d. **Remove Cylinder Head Valve Covers.** Remove four nuts and lock washers holding valve cover breather tube connection to

DISASSEMBLY INTO SUBASSEMBLIES

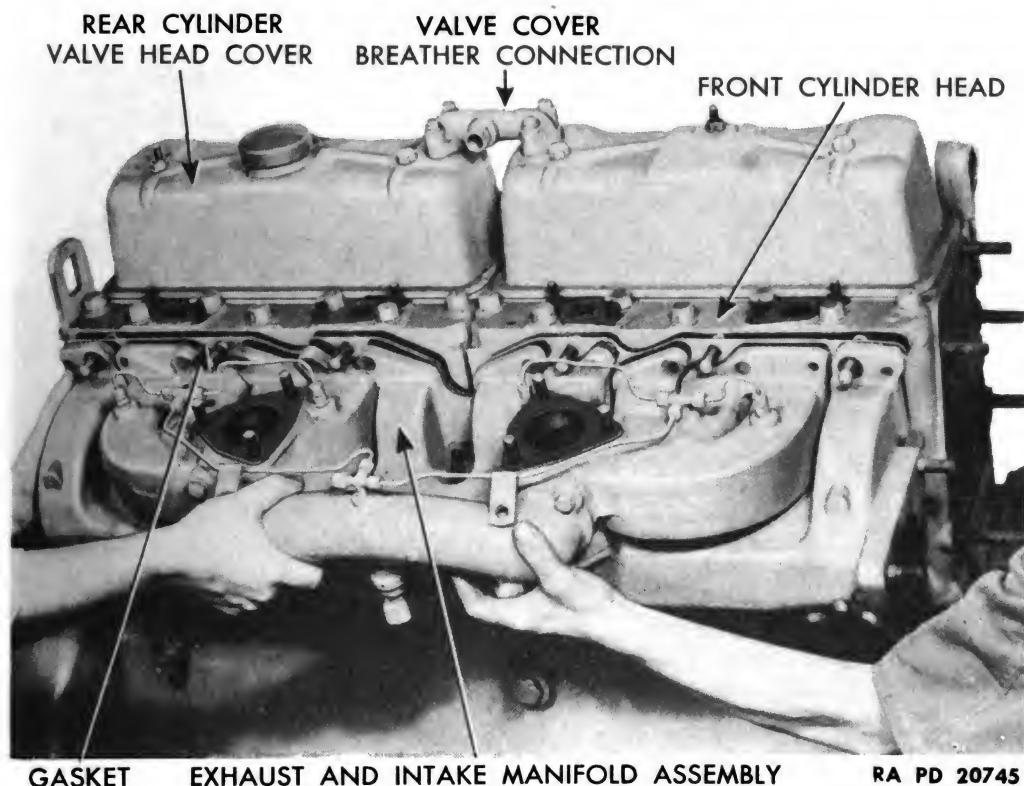


Figure 13 — Removing Exhaust and Intake Manifold Assembly

cylinder head valve covers, and lift connection off four studs (fig. 13). Remove six screws and plain washers holding two cylinder head valve covers to cylinder heads. Lift off covers and gaskets (fig. 14).

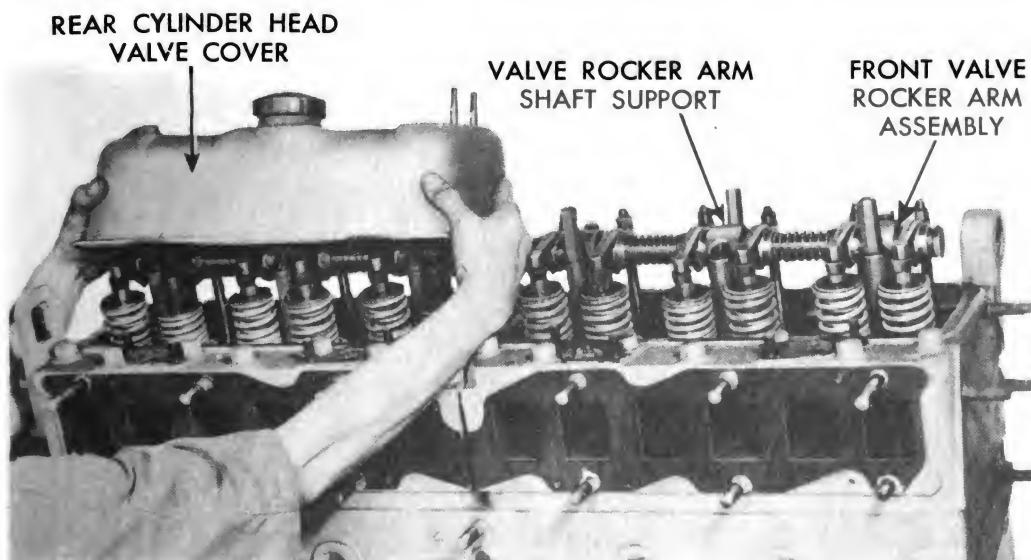


Figure 14 — Removing Rear Cylinder Head Valve Cover

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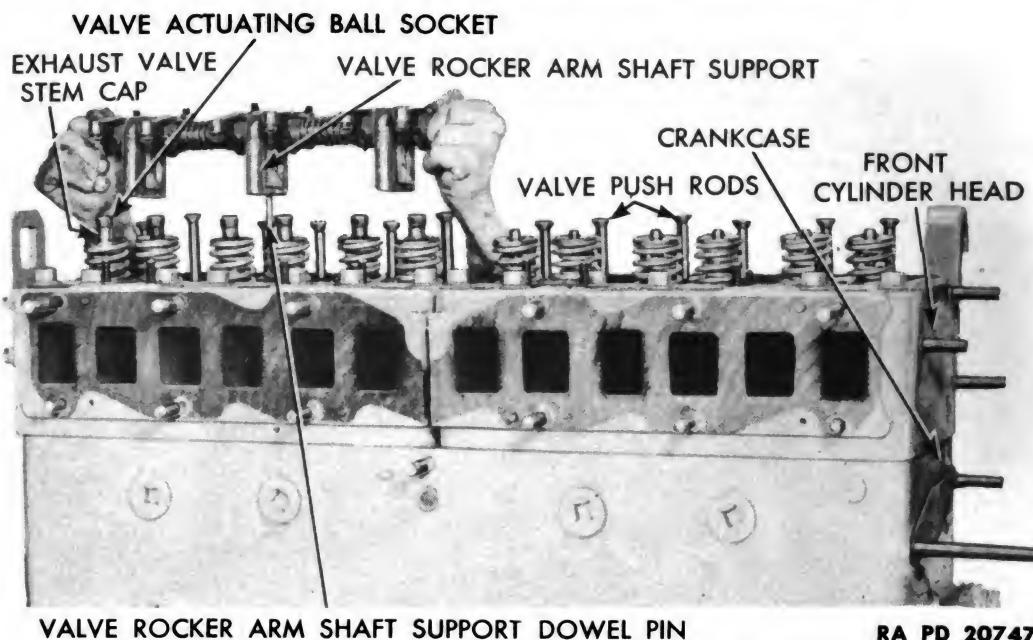


Figure 15 — Removing Valve Rocker Arm Shaft Assembly

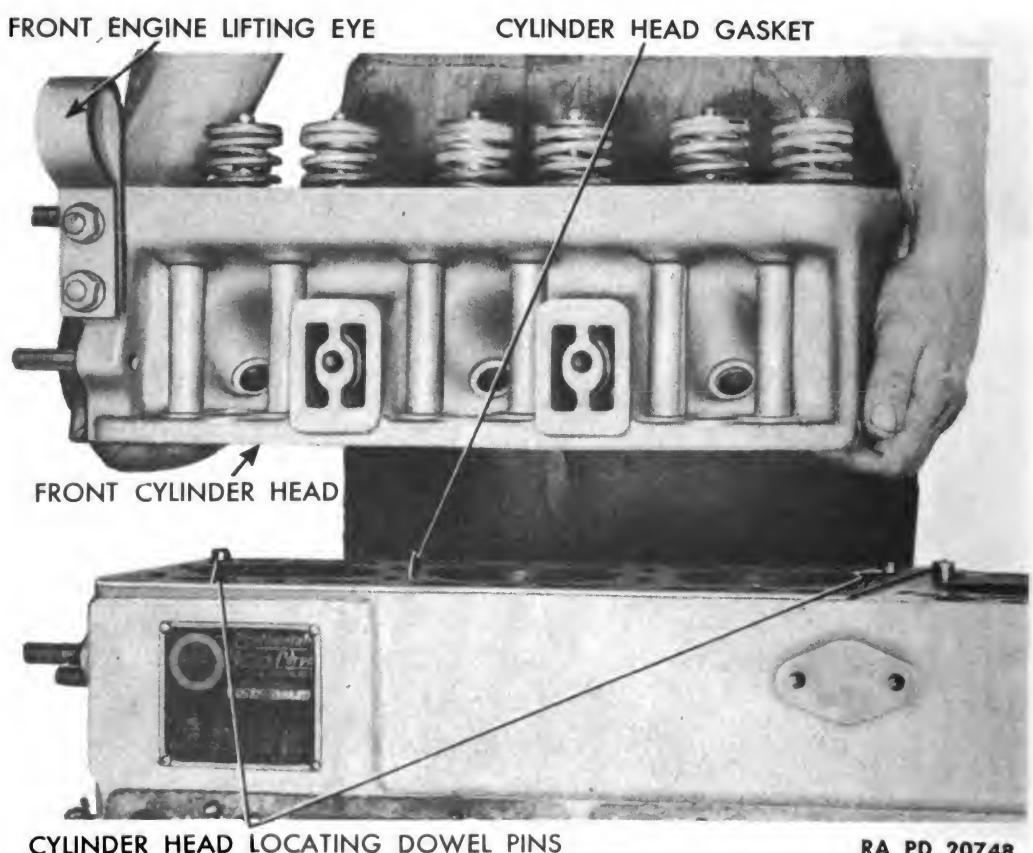


Figure 16 — Removing Front Cylinder Head

DISASSEMBLY INTO SUBASSEMBLIES

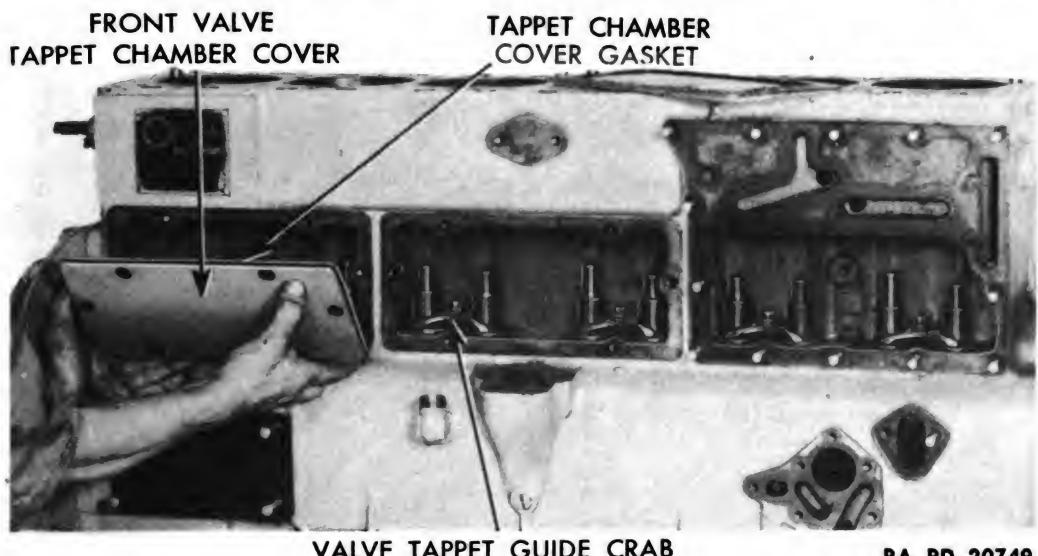


Figure 17 — Removing Valve Tappet Chamber Cover

e. Remove Cylinder Heads. Remove three extension head screws, three cap screws, and six lock washers holding three valve rocker arm shaft supports to front cylinder head (fig. 14). Lift off valve rocker arm shaft assembly. Repeat operation, and remove rear cylinder head valve rocker arm shaft assembly (fig. 15).

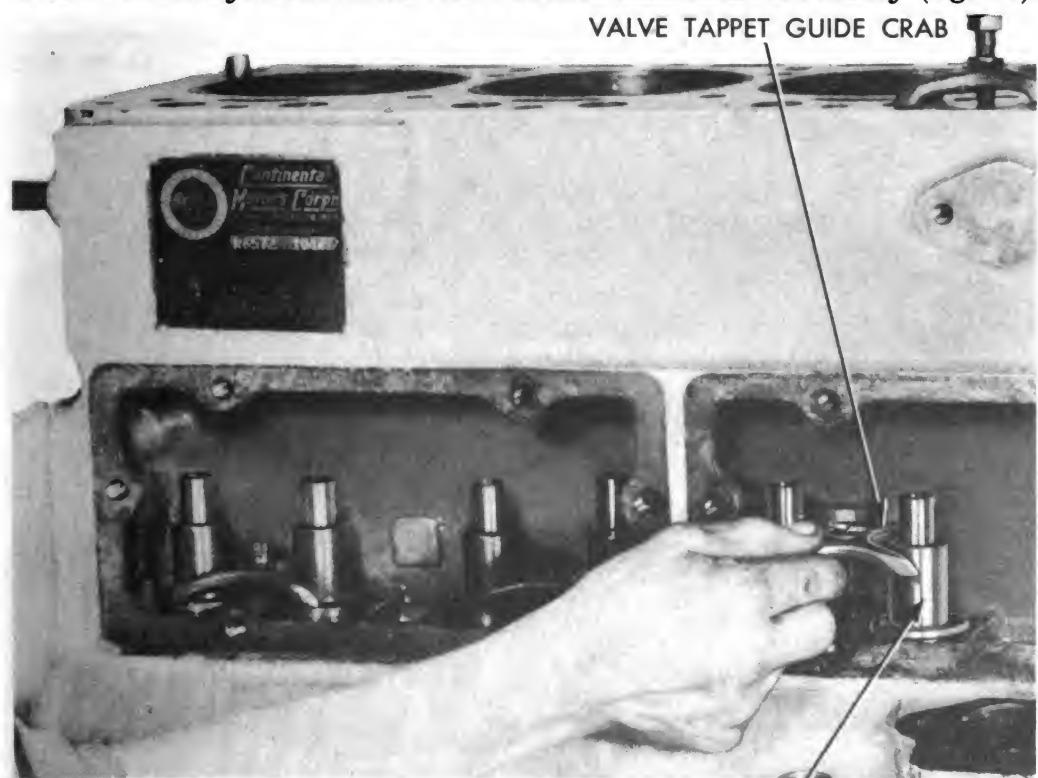
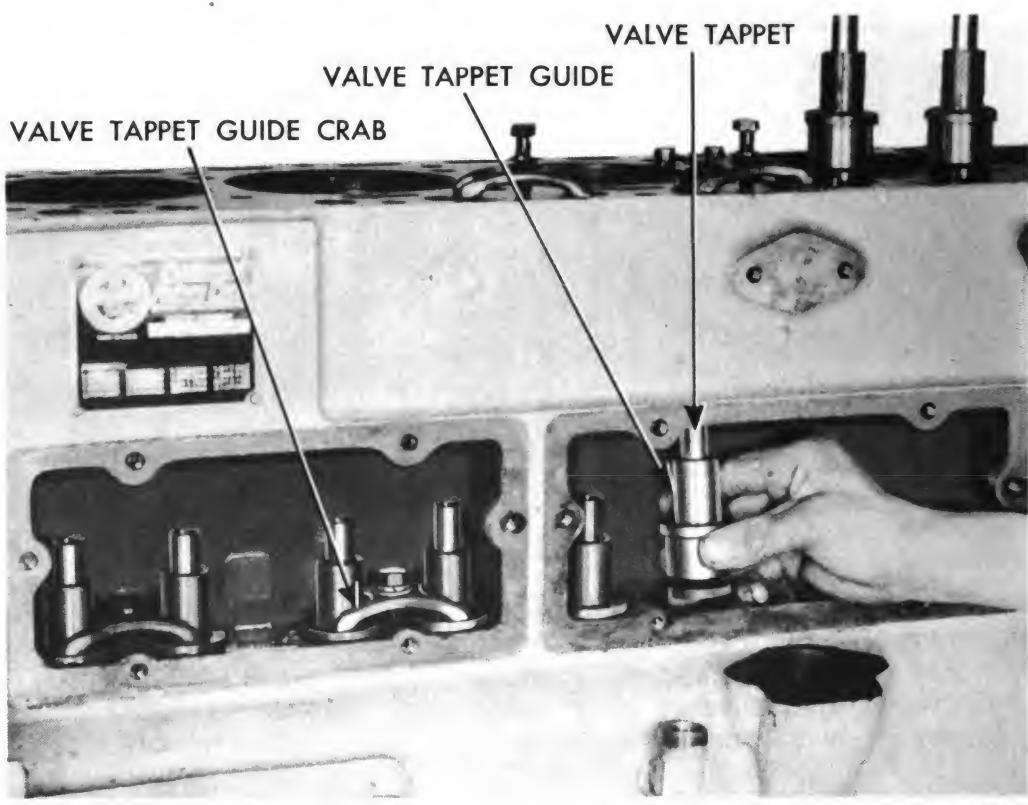
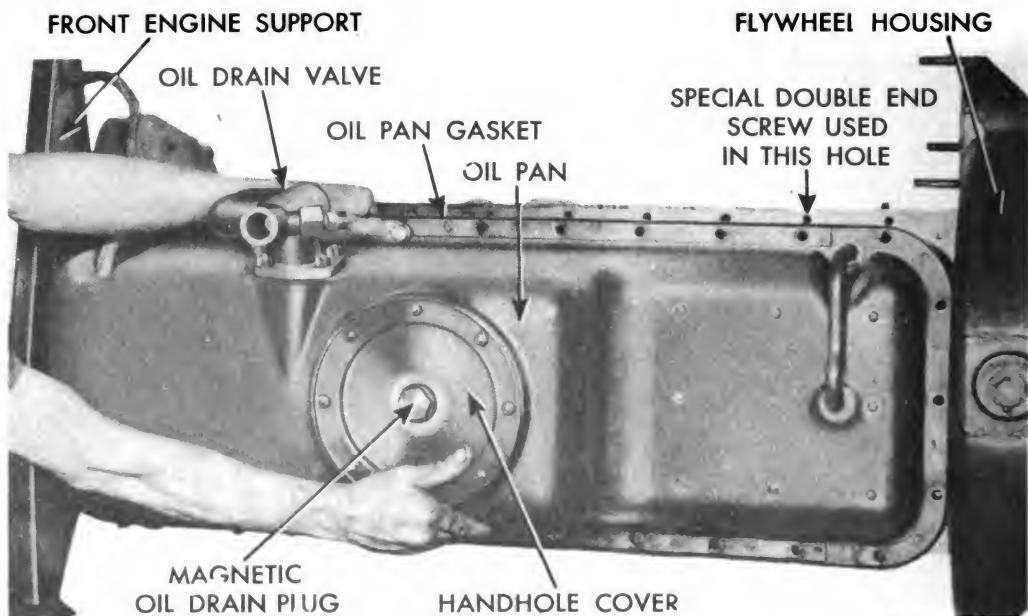


Figure 18 — Removing Valve Tappet Guide Crab

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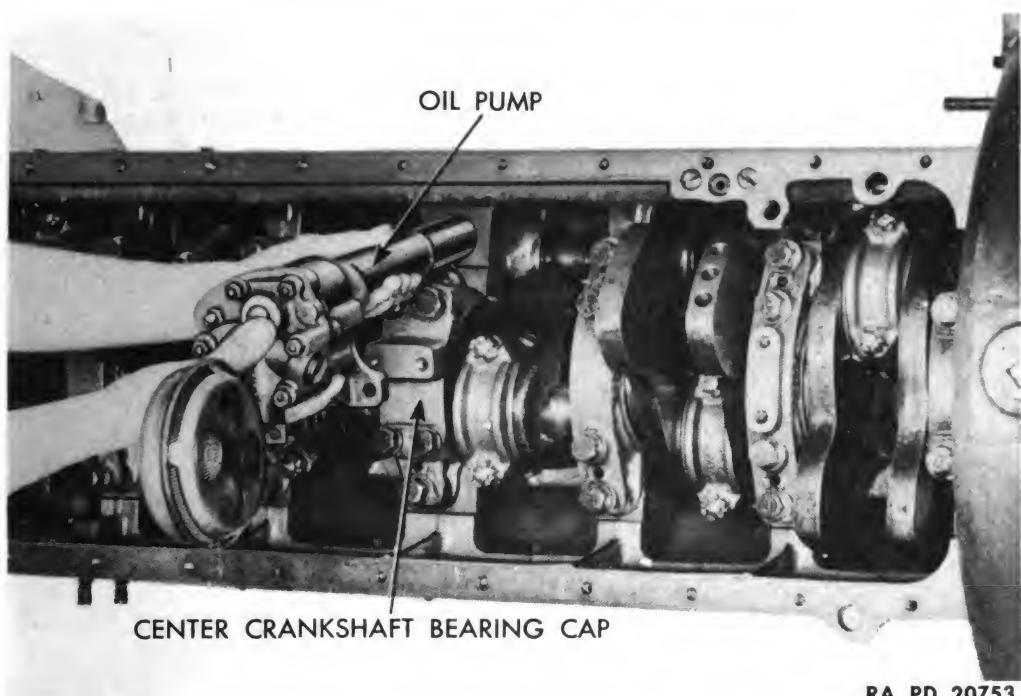
Figure 19 — Removing Valve Tappet and Guide



RA PD 20752

Figure 20 — Removing Oil Pan Assembly

DISASSEMBLY INTO SUBASSEMBLIES



RA PD 20753

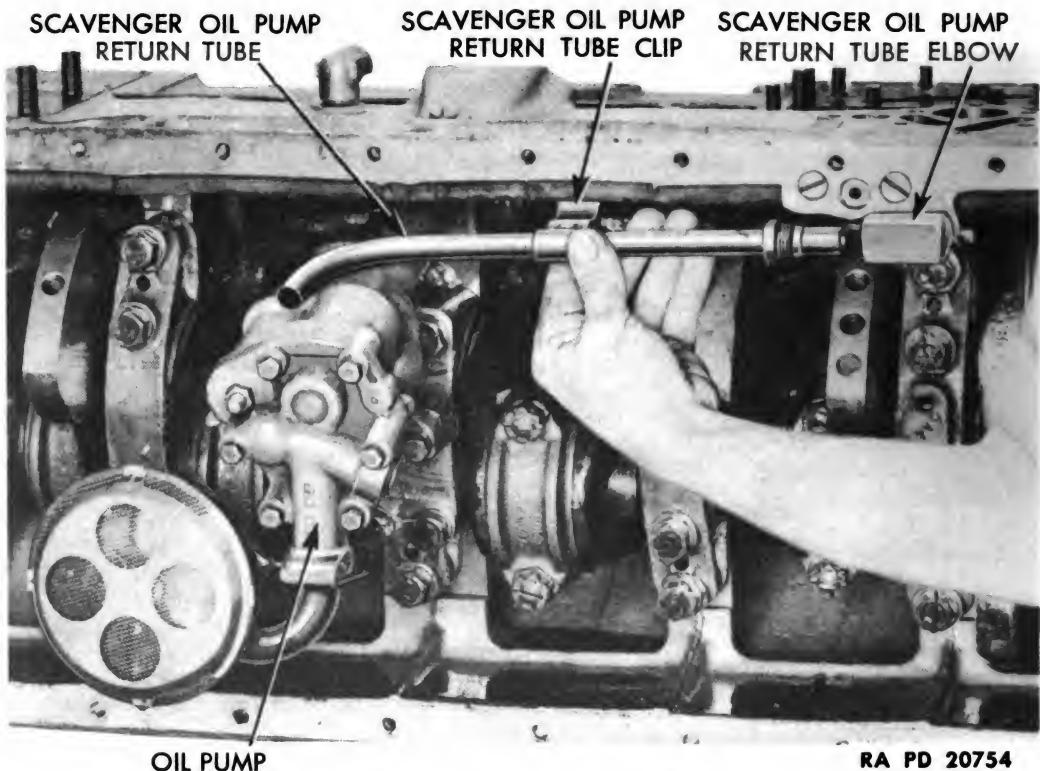
Figure 21 — Removing Scavenger Oil Pump Return Tube

Remove 12 valve actuating ball sockets and 12 valve stem caps from ends of valve stems (fig. 15). Lift out valve push rods (fig. 15). Remove 14 screws and plain washers securing front cylinder head to crankcase. Lift off cylinder head and gasket (fig. 16). Repeat operation to remove rear cylinder head and gasket.

f. **Remove Valve Tappets.** Remove 12 screws and lock washers holding front and center valve tappet chamber covers to cylinder block, and remove covers (fig. 17). NOTE: *Rear chamber was uncovered when oil cooler housing was removed. See TM 9-786.* Remove six screws and lock washers holding six valve tappet guide crabs (fig. 17). Lift off crabs (fig. 18). Lift out 12 tappet guides and tappets (fig. 19). Remove tappets from guides.

g. **Remove Oil Pan.** Revolve engine in stand to horizontal position. Remove 28 screws and lock washers holding oil pan to crankcase. Lift off oil pan (fig. 20).

h. **Remove Scavenger Oil Pump Return Tube.** Remove one nut and lock washer holding tube clip to crankcase. Disconnect tube from elbow, and remove tube (fig. 21). Remove return tube elbow from crankcase.

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RA PD 20754

Figure 22 — Removing Oil Pump

- i. Remove Oil Pump. Remove two cap screws and lock washers attaching oil pump to crankshaft center bearing cap. Pull pump out of crankcase (fig. 22).
- j. Remove Connecting Rods and Pistons. Remove cotter pins from connecting rod bolts. Remove two connecting rod bolt nuts, and pull off bearing cap and lower half of connecting rod bearing (fig. 23). Rotate crankshaft until piston is flush with top of cylinder block. Tap the connecting rod with a hammer handle to force piston out of crankcase so that rod and piston assembly can be pulled out through top of cylinder block (fig. 24). Replace cap on connecting rod, and insert connecting rod bolt nuts fingertight. Remove remaining five rods and pistons in same manner.

DISASSEMBLY INTO SUBASSEMBLIES

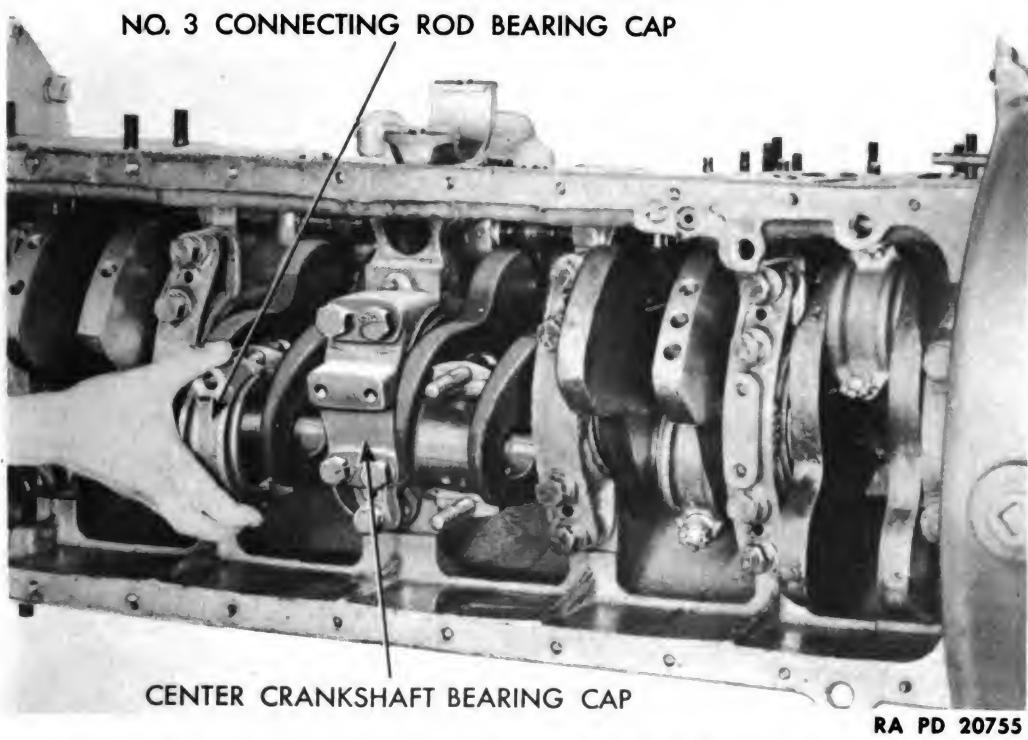


Figure 23 — Removing Connecting Rod Bearing Cap

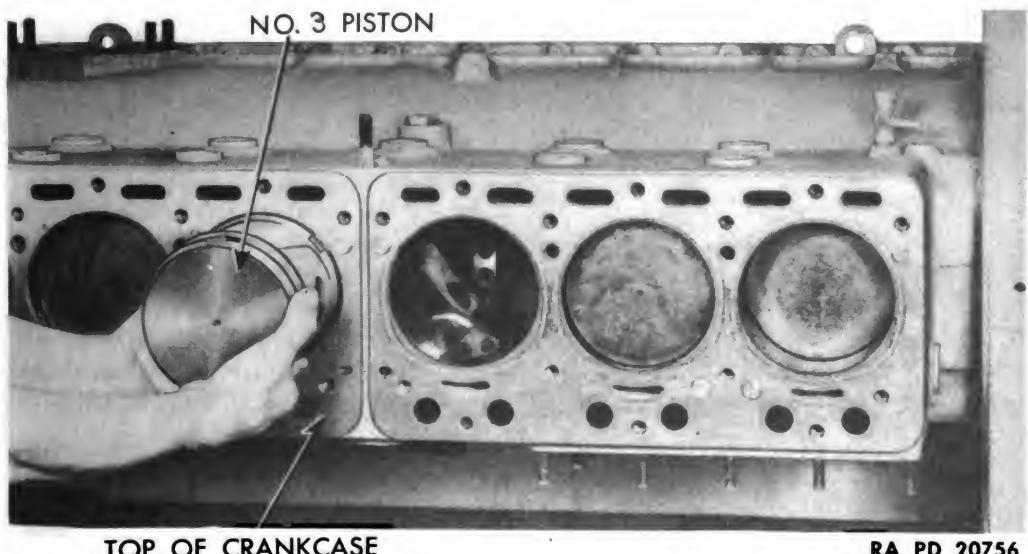
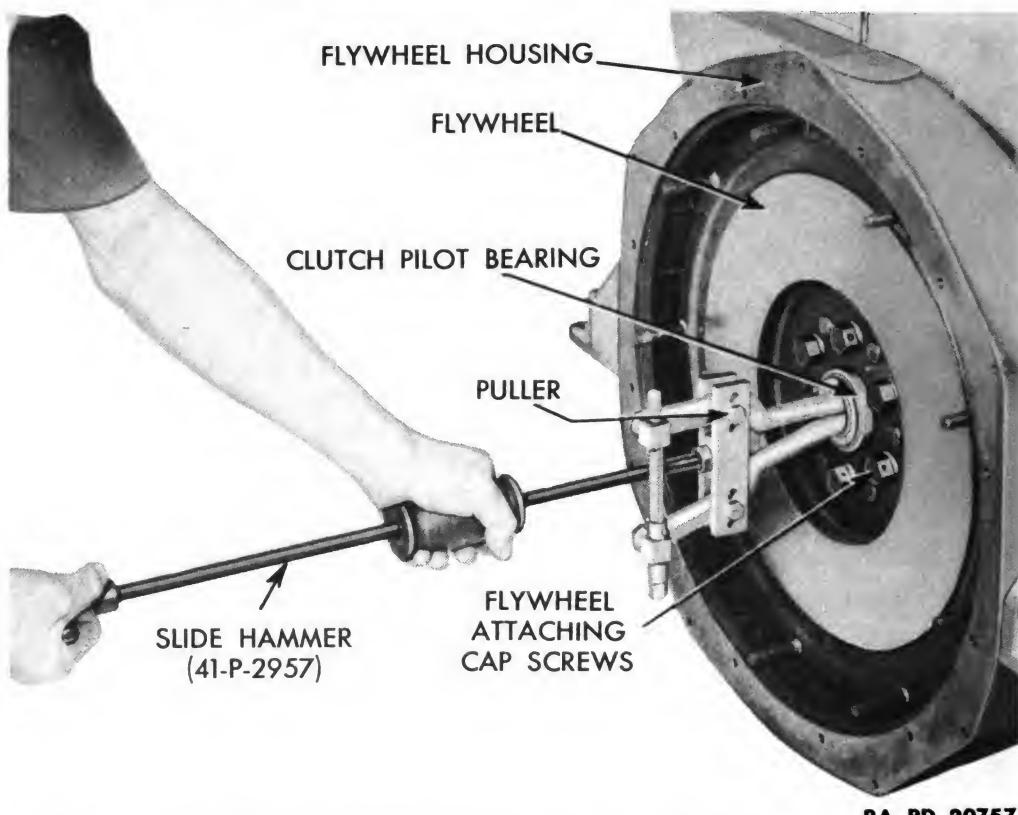


Figure 24 — Removing Piston and Connecting Rod

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RA PD 20757

Figure 25 — Removing Clutch Pilot Bearing, Using Puller and Slide Hammer

k. Remove Flywheel and Flywheel Housing.

(1) **REMOVE CLUTCH PILOT BEARING.** Remove bearing from flywheel with puller and slide hammer (41-P-2957) (fig. 25). If this puller is not available the bearing can be removed by combining the jaws from puller (41-P-2905-60) and slide hammer from puller (41-P-2957), taking care to avoid damaging threads on slide hammer.

(2) **REMOVE FLYWHEEL.** Remove engine from stand, and place it bottom side up and crosswise on stand (fig. 26), or on two blocks of wood. Cut and remove three lock wires from six screws attaching flywheel to crankshaft (fig. 25). Remove six cap screws and lock washers attaching flywheel to crankshaft. Insert three set screws ($\frac{1}{2}$ -13NC x 3) in threaded holes (fig. 26). Turn screws alternately until flywheel is forced off crankshaft. Lift flywheel out of housing (fig. 27).

(3) **REMOVE FLYWHEEL HOUSING.** Remove 10 nuts from studs holding flywheel housing to crankcase. Tap housing at alternate points around the rim to pull dowel pins. Lift off housing (fig. 28).

DISASSEMBLY INTO SUBASSEMBLIES

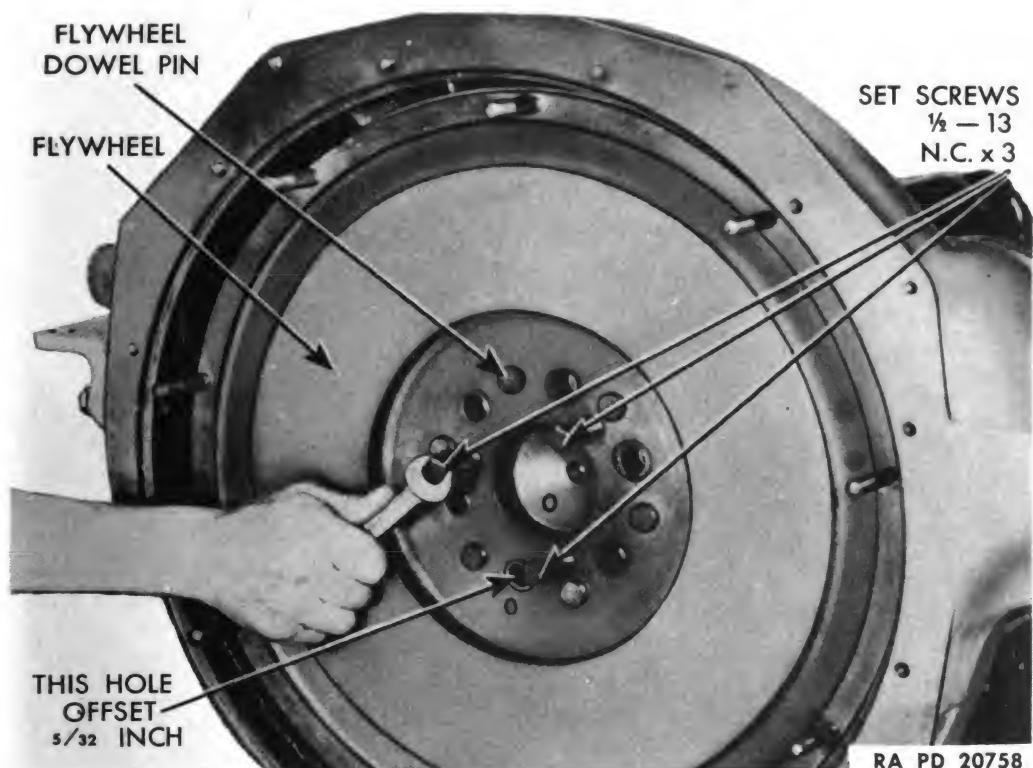
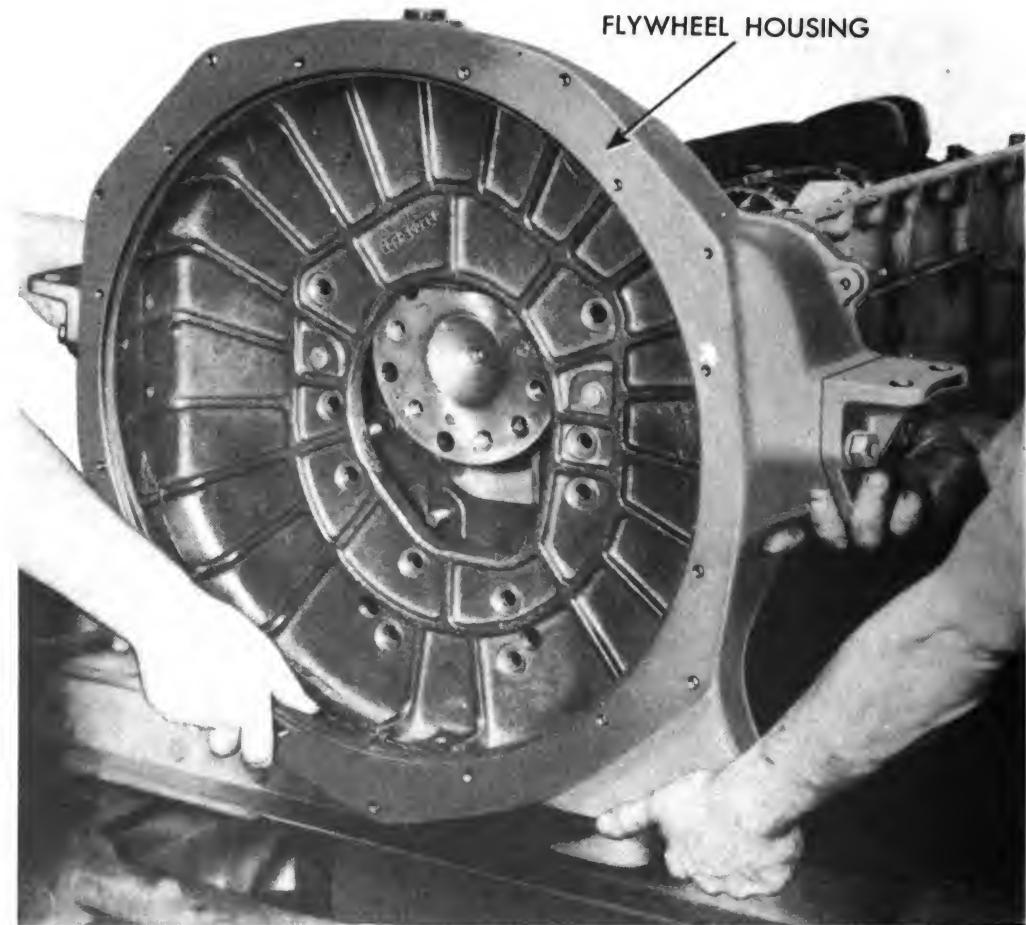


Figure 26 — Forcing Flywheel Off Crankshaft Flange with Set Screws



Figure 27 — Removing Flywheel

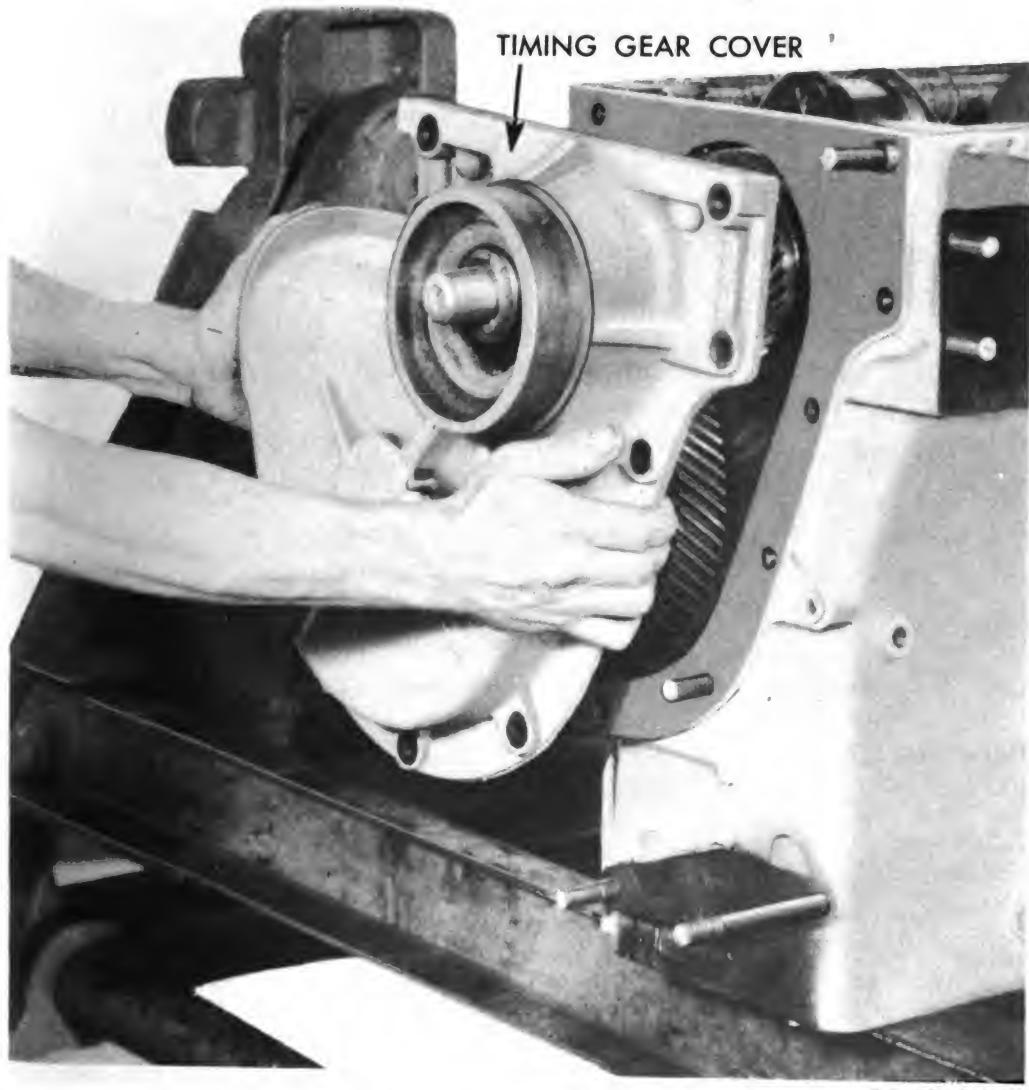
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RA PD 20760

Figure 28 — Removing Flywheel Housing

DISASSEMBLY INTO SUBASSEMBLIES



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Figure 29 — Removing Timing Gear Cover

1. **Remove Timing Gear Cover.** Remove 7 cap screws, 5 nuts, and 12 lock washers attaching cover to crankcase. Lift off cover (fig. 29).

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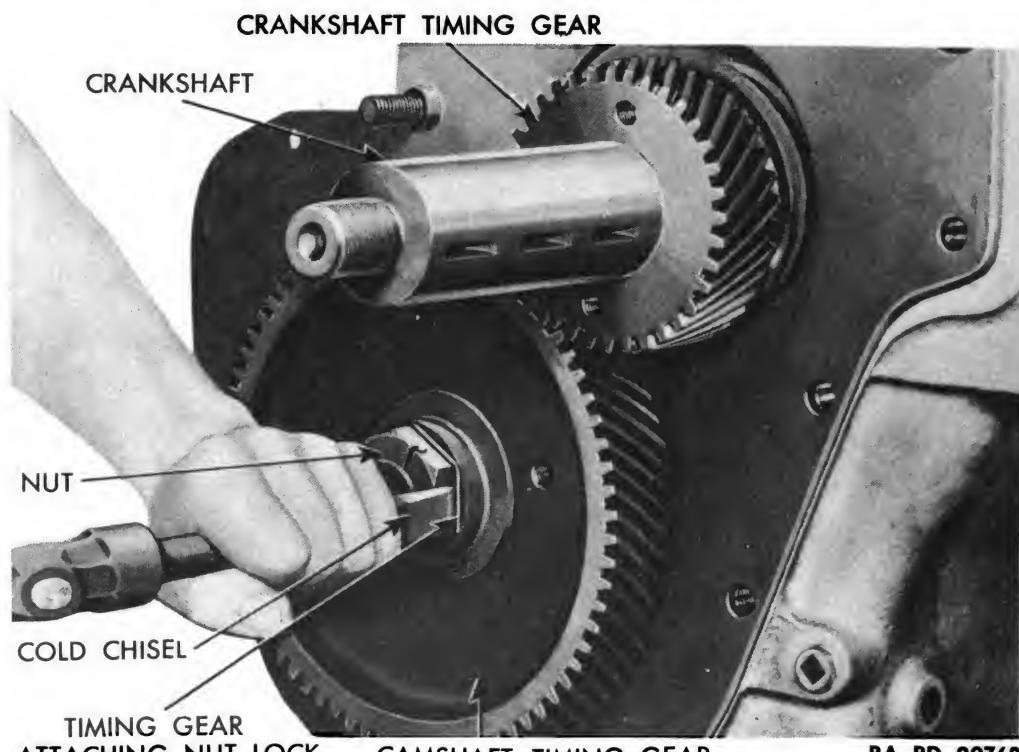


Figure 30 — Straightening Edges of Camshaft Timing Gear Attaching Nut Lock

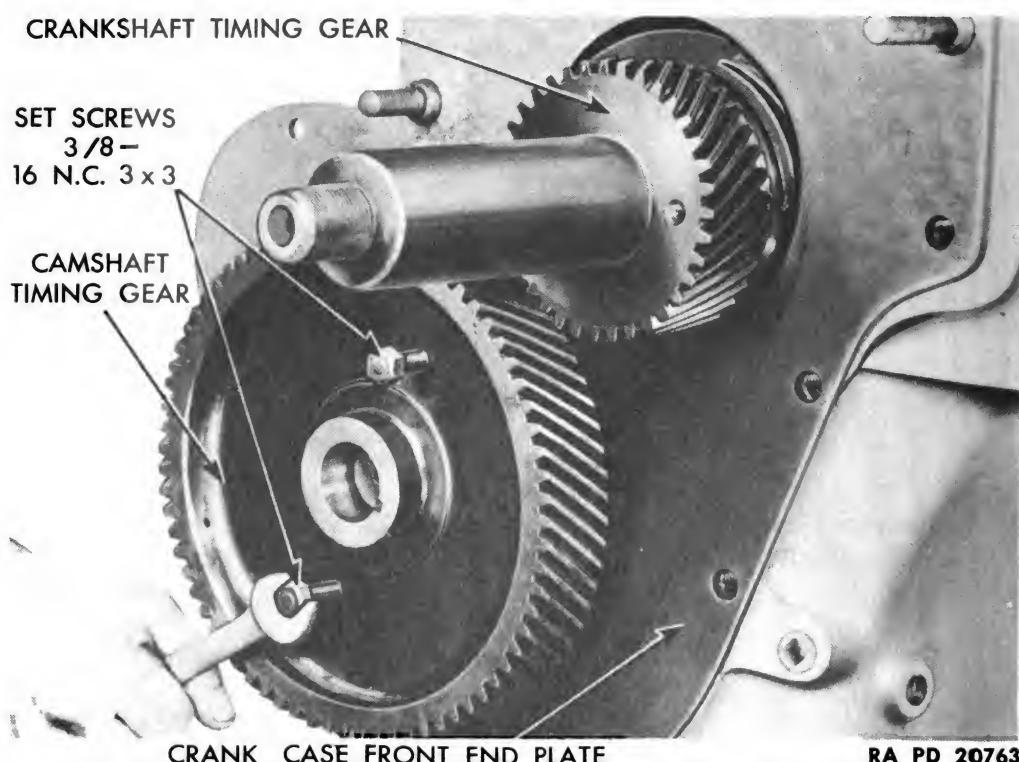


Figure 31 — Removing Camshaft Timing Gear, Using Two Set Screws

DISASSEMBLY INTO SUBASSEMBLIES

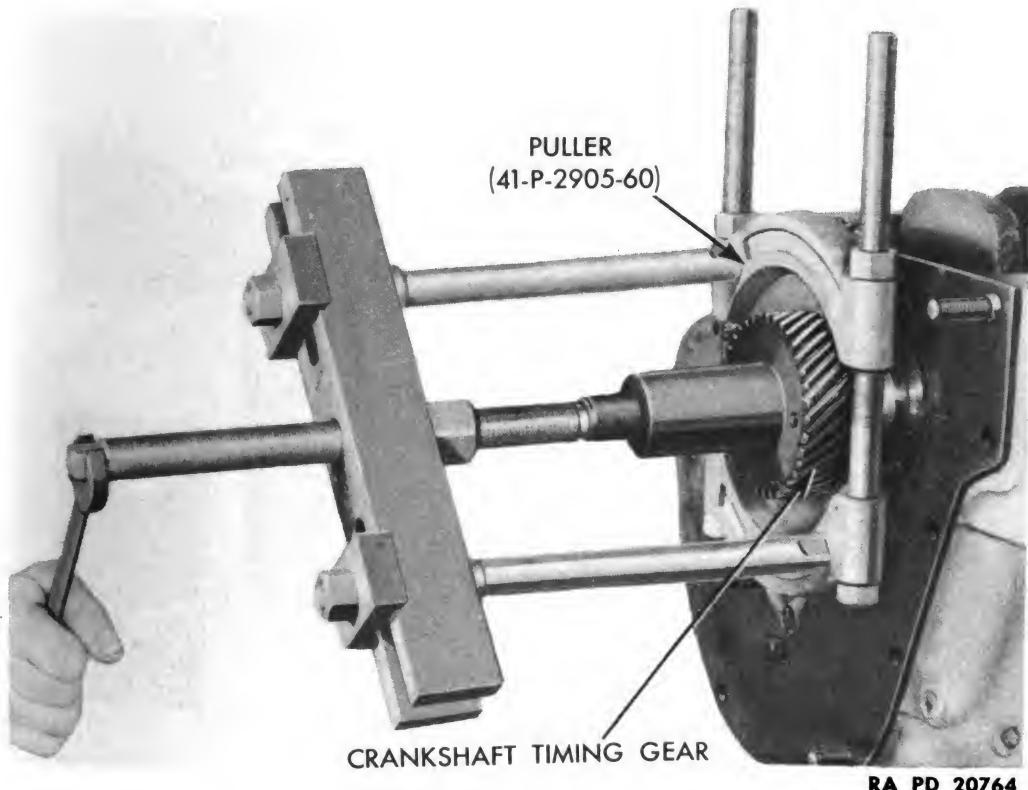


Figure 32 — Removing Crankshaft Timing Gear with Puller

m. Remove Crankshaft and Camshaft Timing Gears. Pry three keys from front end of crankshaft, and slide off oil flinger. Drive edge of camshaft timing gear attaching nut lock away from nut (fig. 30), and remove nut. Insert two set screws ($\frac{3}{8}$ -16NC-3 x 3) in tapped holes in camshaft timing gear. Turn screws in against front end plate, alternately, a few turns at a time, until gear is forced off camshaft (fig. 31). Remove crankshaft timing gear with puller (41-P-2905-60) (fig. 32).

n. Remove Crankcase Front End Plate. Remove three cap screws and lock washers holding front end plate to crankcase. Loosen end plate from two ring dowels with rawhide mallet, and lift off (fig. 33).

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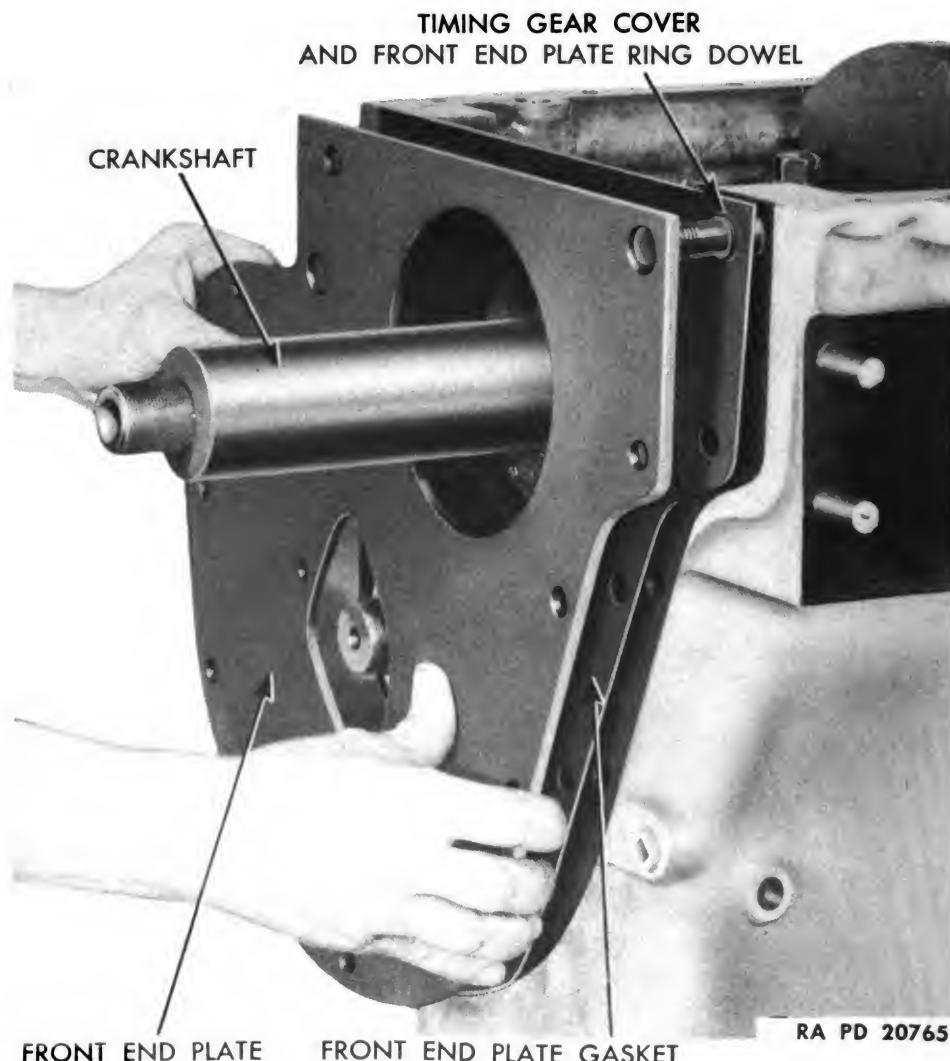
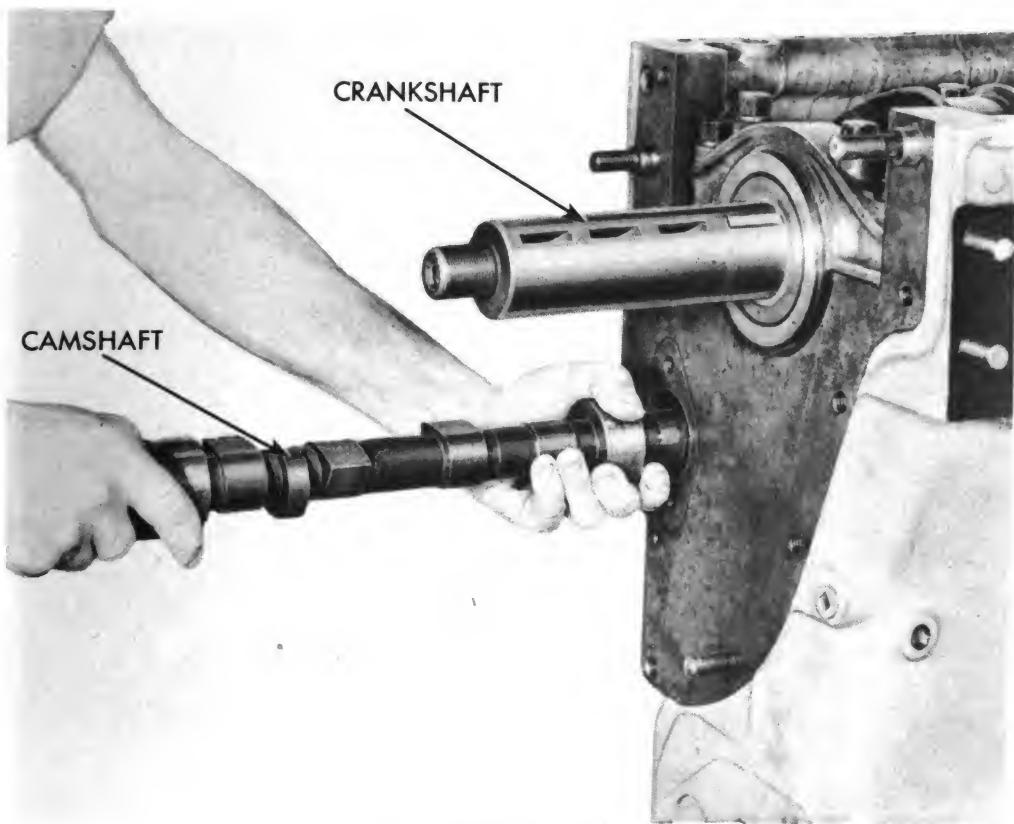


Figure 33 — Removing Crankcase Front End Plate

DISASSEMBLY INTO SUBASSEMBLIES



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Figure 34 — Removing Camshaft

o. Remove Camshaft. Remove two screws attaching camshaft thrust plate to crankcase, and remove plate. Pull camshaft out through front end of crankcase (fig. 34). Care must be used when pulling out camshaft to prevent damage to camshaft bushings in the crankcase.

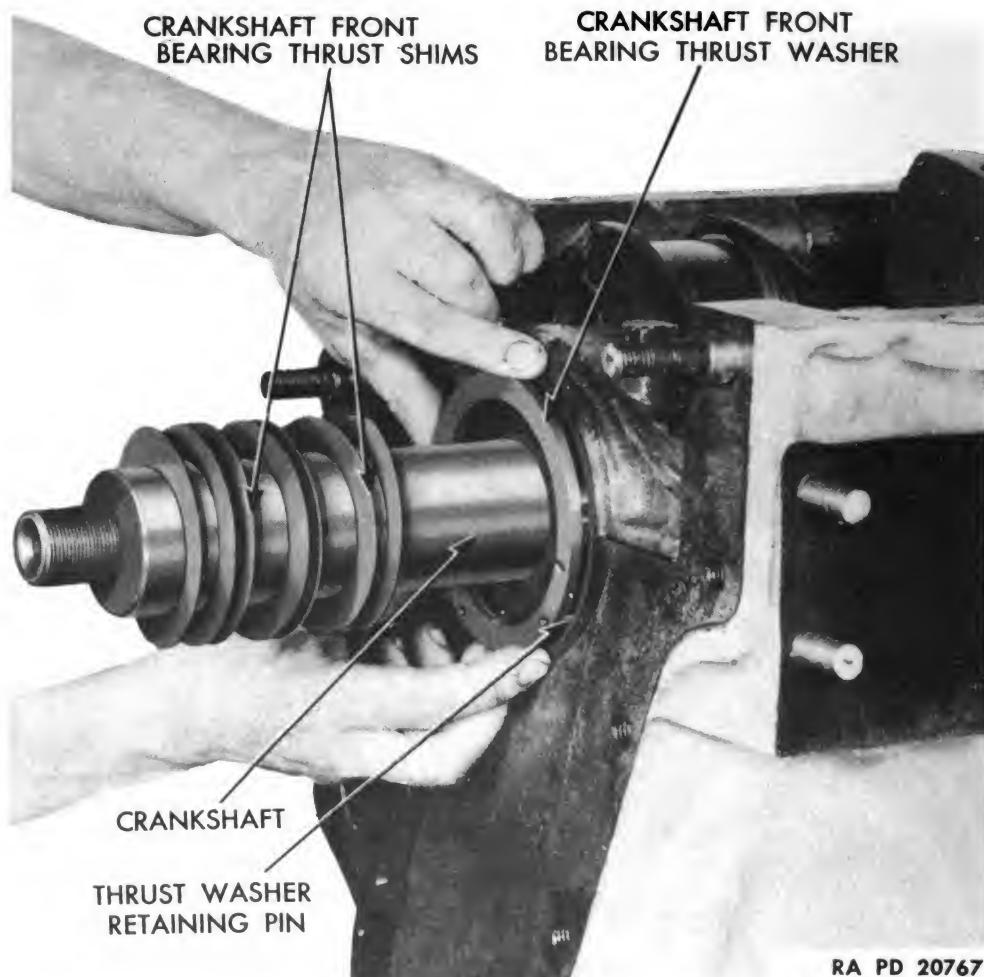
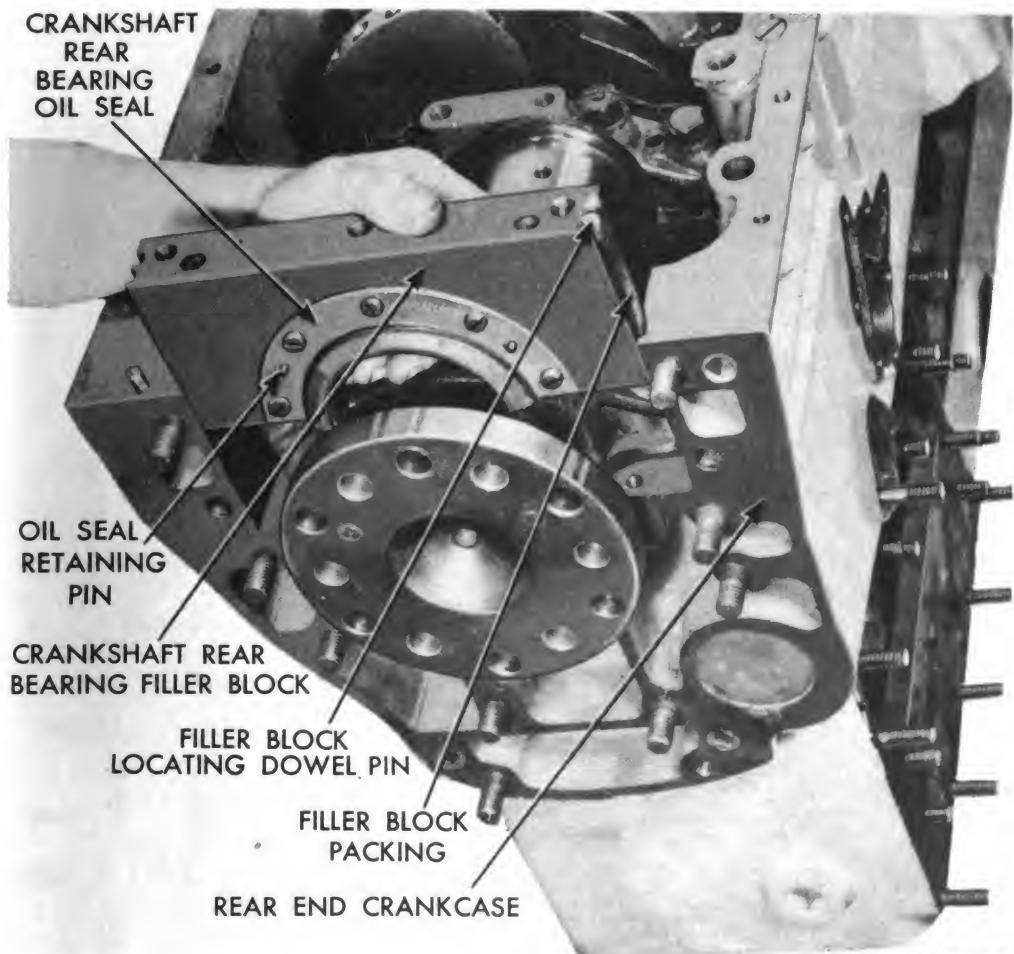
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Figure 35 — Removing Crankshaft Front Bearing Thrust Washer and Shims

p. Remove Crankshaft. Pry crankshaft front bearing thrust washer off retaining pins in front end of crankcase (fig. 35). Remove crankshaft front bearing thrust shims (fig. 35), and tie them together to facilitate reassembly. Remove two cap screws and lock washers attaching rear bearing filler block to crankcase. Lift

DISASSEMBLY INTO SUBASSEMBLIES



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Figure 36 — Removing Crankshaft Rear Bearing Filler Block with Oil Seal

filler block out of crankcase (fig. 36). Remove two locating dowel pins from filler block (fig. 36). Remove five screws and plain washers attaching lower half of oil seal to filler block. Pry oil seal (fig. 36) off retaining pins, and remove from filler block. Cut and remove lock wires from main bearing cap screws. Remove 31

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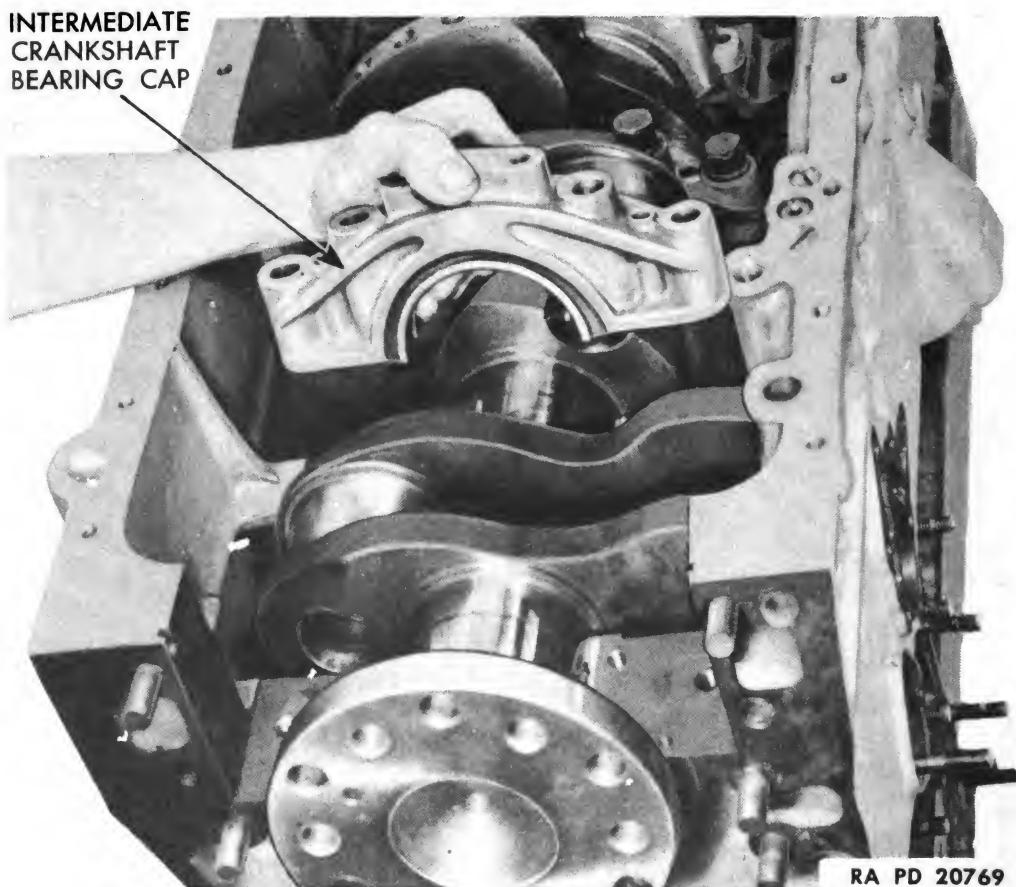


Figure 37 — Removing Crankshaft Intermediate Bearing Cap

DISASSEMBLY INTO SUBASSEMBLIES

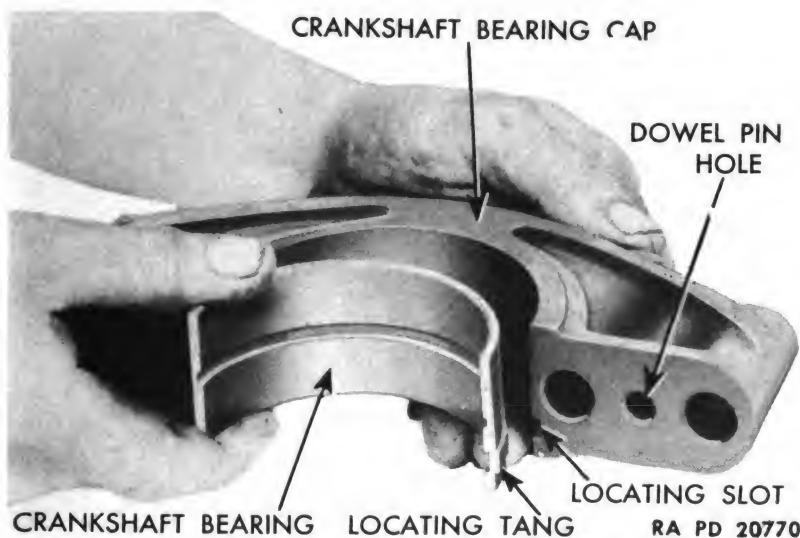


Figure 38 — Removing Crankshaft Bearing from Bearing Cap

screws and plain washers holding main bearing caps to crankcase. Lift out seven bearing caps (fig. 37). Remove lower half of crankshaft bearings from bearing caps (fig. 38). Lift crankshaft out carefully to avoid "nicking" bearing journals (fig. 39). Remove upper halves of crankshaft bearings from crankcase (fig. 40). Remove five screws and plain washers, and remove upper half of crankshaft rear bearing oil seal from cylinder block (fig. 77).

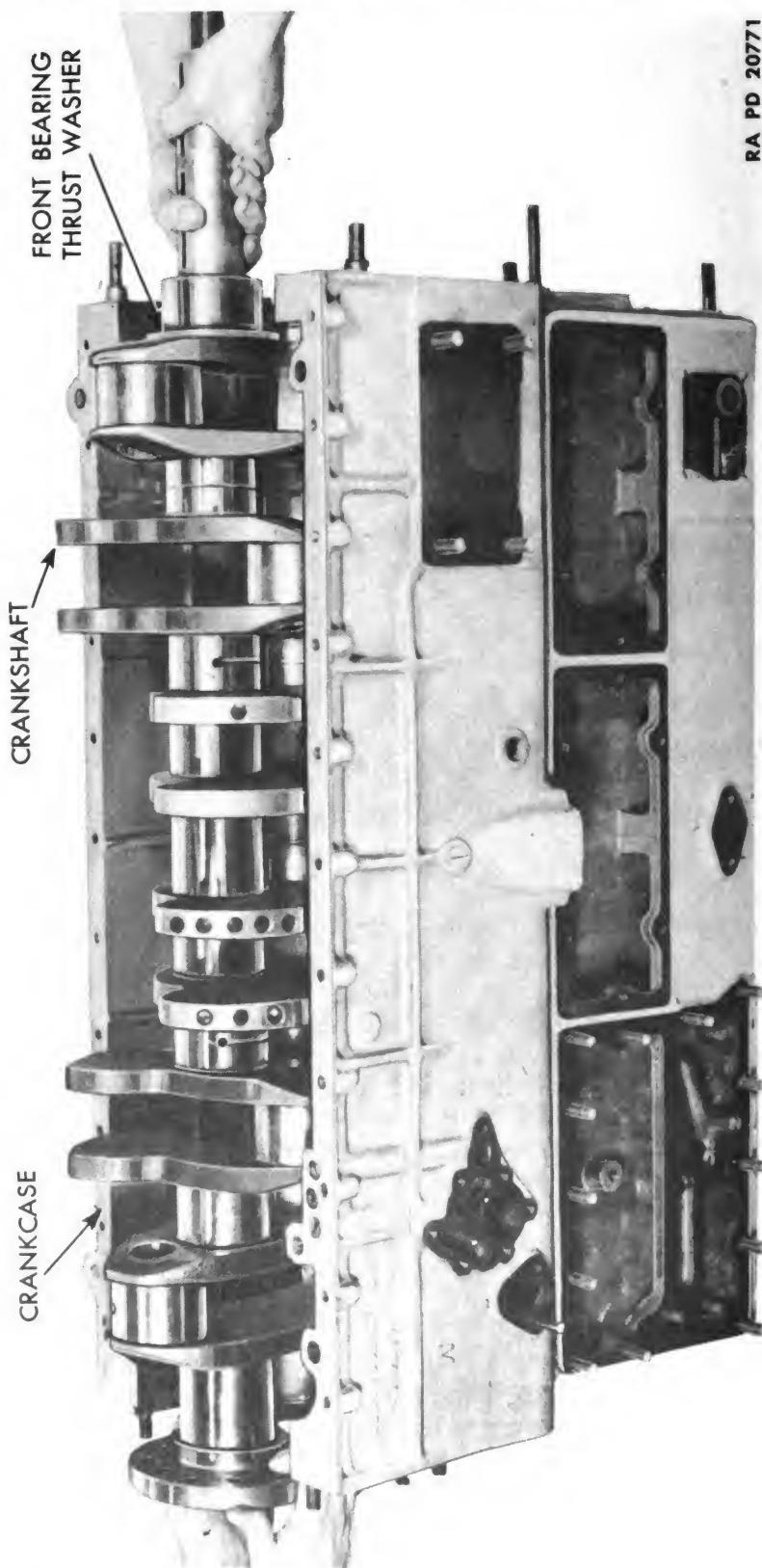
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Figure 39 — Removing Crankshaft

DISASSEMBLY INTO SUBASSEMBLIES

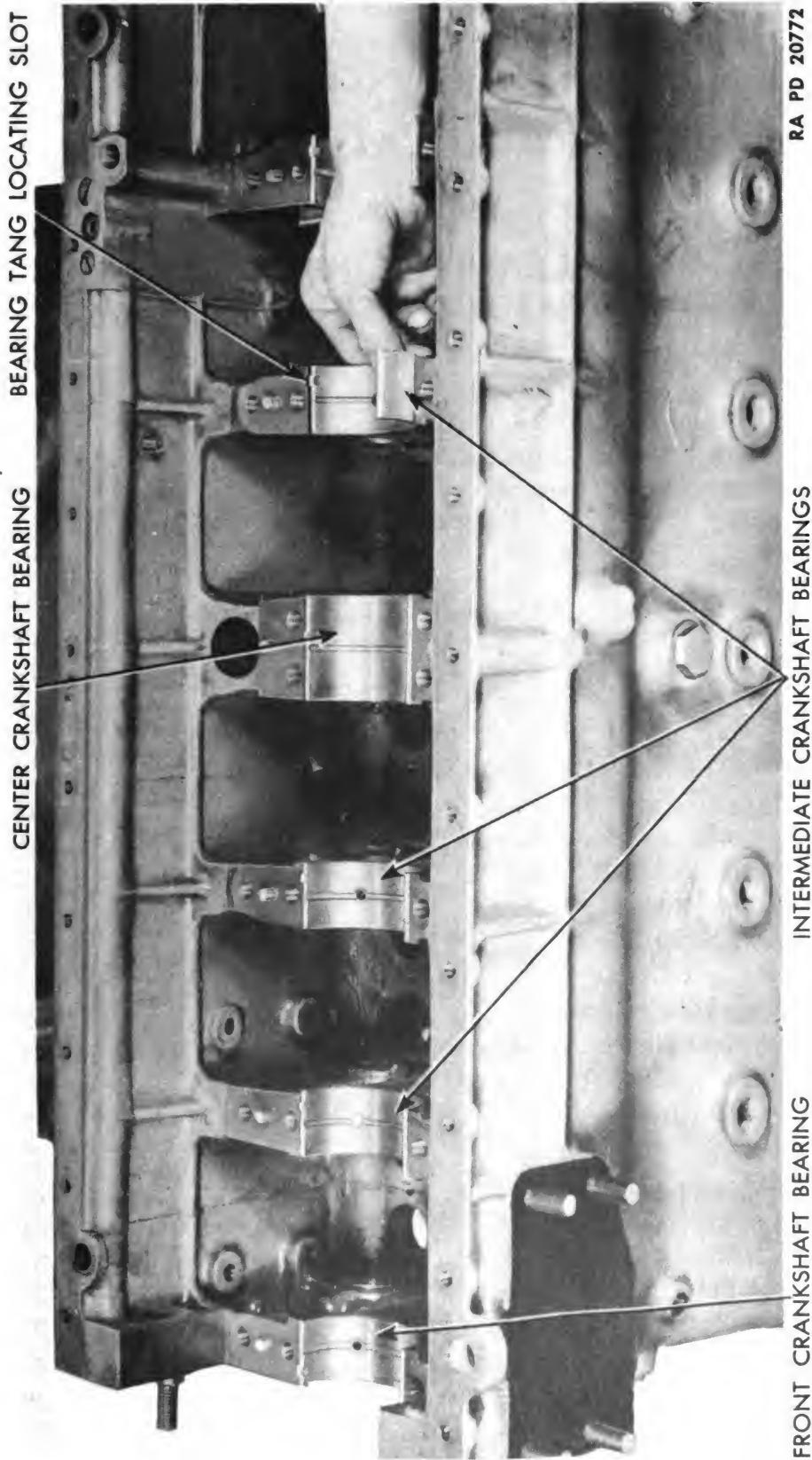


Figure 40 — Removing Crankshaft Bearings from Crankcase

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CHAPTER 2 (Cont'd)

ENGINE MODEL R6572 (Cont'd)

Section III

**DISASSEMBLY, CLEANING, INSPECTION, REPAIR,
AND ASSEMBLY OF SUBASSEMBLIES**

	Paragraph
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Cylinder heads.....	8
Rocker arms and rocker arm shaft.....	9
Connecting rods and pistons.....	10
Crankshaft.....	11
Flywheel.....	12
Flywheel housing.....	13
Timing gears.....	14
Front end plate.....	15
Timing gear cover.....	16
Oil pan.....	17
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Cylinder head valve covers.....	19
Valve tappets.....	20
Valve tappet guides.....	21
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**DISASSEMBLY, CLEANING, INSPECTION, REPAIR, AND
ASSEMBLY OF SUBASSEMBLIES**

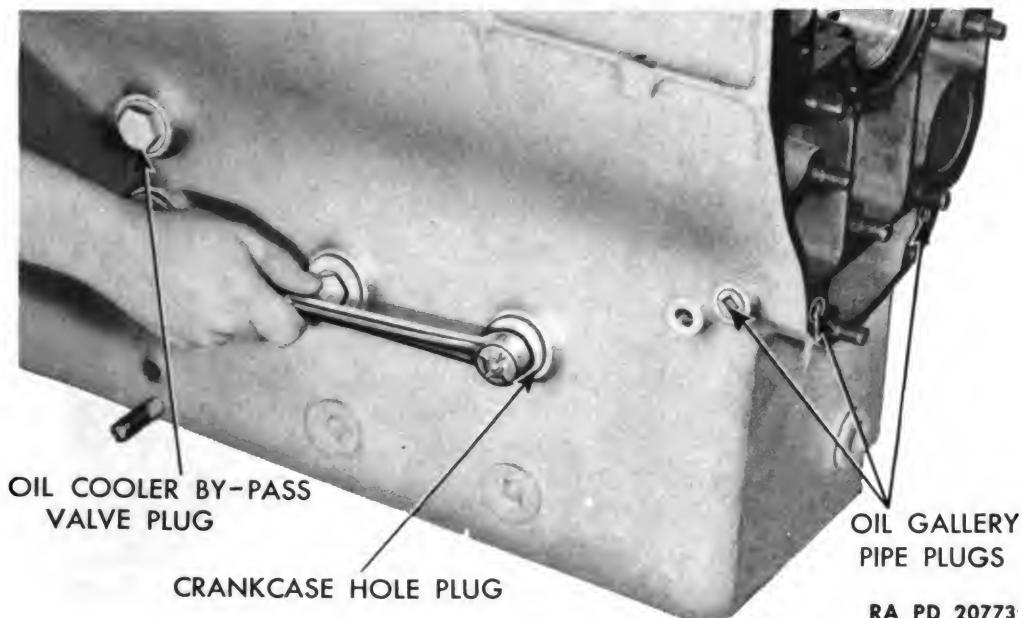


Figure 41 — Removing Crankcase Core Hole Plugs

7. CRANKCASE.

a. **Clean.** Strip off gaskets and sealing compound from all surfaces. Remove pipe plugs from oil gallery at both ends of crankcase, and remove 10 crankcase core hole plugs (fig. 41). Clean inside and outside of crankcase with dry-cleaning solvent or with steam. **CAUTION:** *Be sure to clean oil gallery and water jacket.* Blow out oil gallery and water jacket with compressed air. Replace oil gallery pipe plugs, using joint and thread compound. Replace 10 crankcase core hole plugs, using new copper asbestos gaskets.

b. **Inspect.**

(1) **CAMSHAFT BEARINGS.** Measure each of the five camshaft bearings. The inside diameter of new bearings is 2.1240 to 2.1245 inches. If bearings are worn, replace as described in subparagraph c (1) below.

(2) **CRANKCASE.** Inspect all surfaces of crankcase for cracks, paying particular attention to top surface of cylinder around the bores. Inspect all studs, and replace those that are broken or bent, or that have stripped threads. Check condition of cylinder head dowel pins and front end plate dowel pins. Inspect all milled surfaces, and if nicked or burred, smooth down with a fine file. Measure cylinder bores. New bores measure 4.749 to 4.751 inches. Taper of 0.001 inch and out-of-round of 0.001 inch is permissible. Measure the bores to determine taper and out-of-round caused by wear. Measure the bores approximately 1 inch below top surface of crankcase, and also near bottom of bore. Inspect bores for scores. If bores are worn or scored, refer to subparagraph c (2) below for refinishing.

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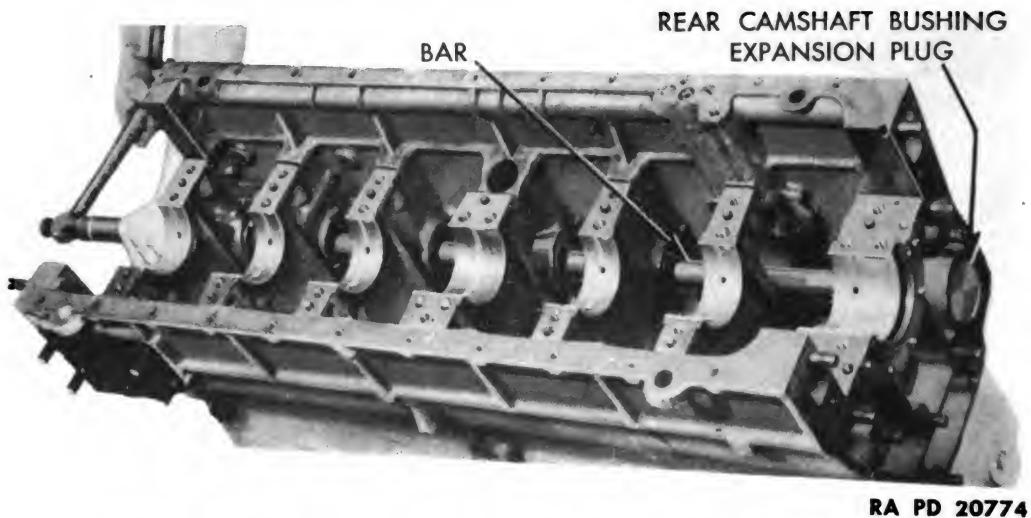


Figure 42 — Removing Rear Camshaft Bushing Expansion Plug

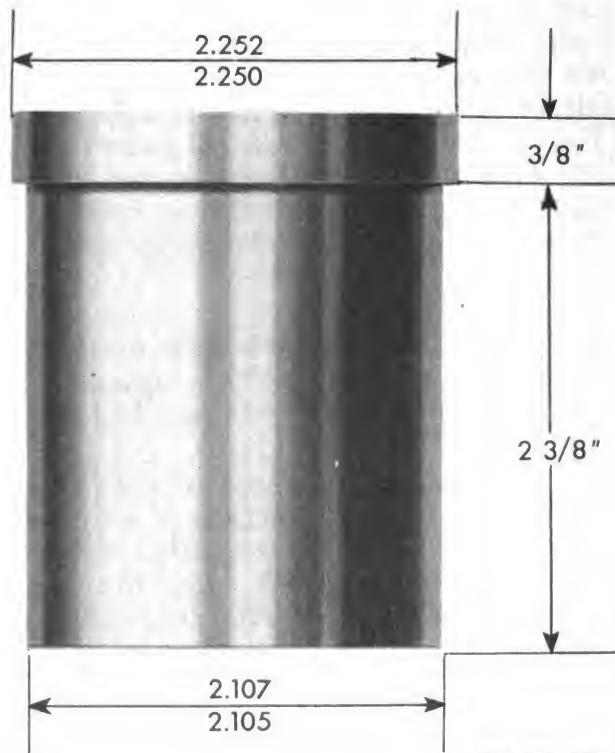


Figure 43 — Camshaft Bushing Removing and Replacing Tool

**DISASSEMBLY, CLEANING, INSPECTION, REPAIR, AND
ASSEMBLY OF SUBASSEMBLIES**

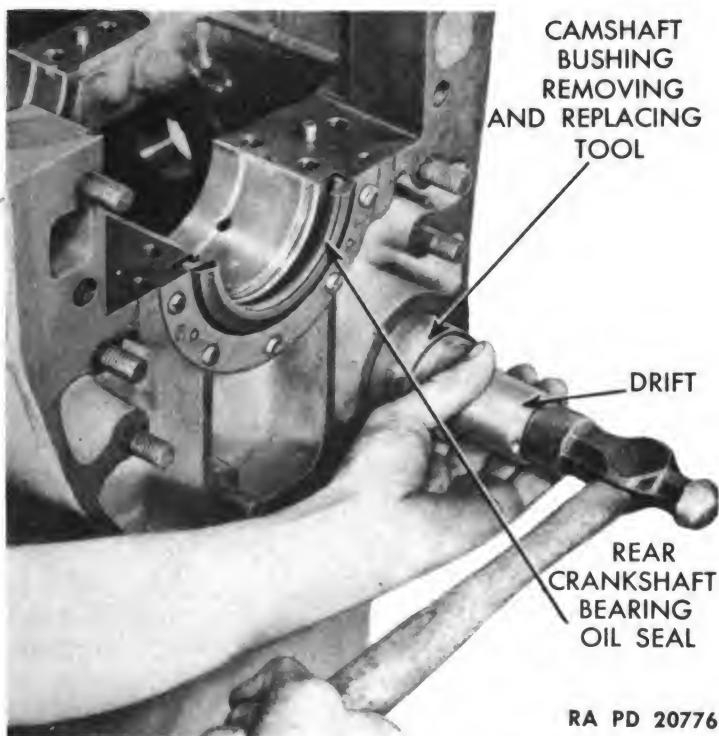


Figure 44 — Removing Camshaft Bushings

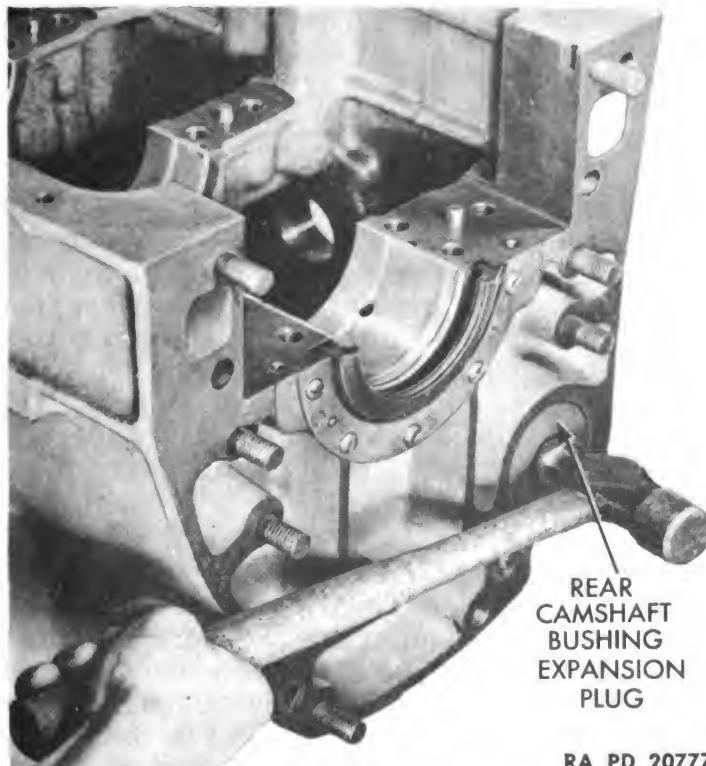


Figure 45 — Installing Rear Camshaft Bushing Expansion Plug

**DISASSEMBLY, CLEANING, INSPECTION, REPAIR, AND
ASSEMBLY OF SUBASSEMBLIES****8. CYLINDER HEADS.**

a. **Disassemble.** Place cylinder head on its side on bench. Place valve lifter (41-L-1408) in position on valve (fig. 46). Head of valve lifter ratchet arm should be against head of valve, and spring clip arm of lifter should slide over valve spring retainer on other side of head. Rotate ratchet knob on lifter until arms of lifter contact head of valve and spring retainer. Depress lever of lifter and compress valve spring. Remove valve spring retainer locks and release valve lifter. Remove valve spring retainers and valve springs. Remove oil guards and oil guard gaskets from intake valves. With a screwdriver, pry snap rings from valves. Remove valves and place them in numbered holes in a board to facilitate reassembly in proper ports.

b. Clean.

(1) **CYLINDER HEADS.** Strip off gaskets and sealing compound from all machined surfaces. Clean cylinder head with dry-cleaning solvent or steam. Scrape the carbon from the combustion chambers. Clean inside diameter in valve guide with a valve guide cleaner. Rotate cleaner in guide several times until all carbon, gum, and other foreign material is removed.

(2) **VALVES.** Remove carbon and gum from heads and stems of valves with a wire buffer.

(3) **VALVE SPRINGS, RETAINERS, LOCKS, AND OIL GUARDS.** Wash valve springs, retainers, locks, and oil guards in dry-cleaning solvent.

c. Inspect.

(1) **CYLINDER HEADS.** Examine all surfaces of cylinder head for cracks, particularly around valve seats and around edges of combustion chamber. NOTE: *Cracked heads should be discarded.* Examine valve seats and exhaust valve seat inserts. Refer to subparagraph d (1) below for reconditioning of valve seats.

(2) **VALVES.** Inspect valves for burned seats and bent stems. Discard valves with bent stems or badly burned seats. Check diameter of valve stem. New exhaust valve stems measure 0.494 to 0.495 inch. New intake valve stems measure 0.4969 to 0.4977 inch.

(3) **VALVE SPRINGS.** Measure free length of valve springs. New springs are $2\frac{7}{8}$ inches long. Check springs in spring scale. New outer springs check 70 pounds, plus or minus 2 pounds, and new inner springs check 35 pounds, plus or minus 2 pounds, when compressed to a length of $2\frac{1}{4}$ inches. Discard springs which fall below these limits.

(4) **VALVE SPRING RETAINERS AND LOCKS.** Examine retainers and locks for wear, and discard any parts showing excessive wear.

(5) **VALVE GUIDES.** With a suitable plug gage, check inside diameter of valve guides. New valve guides measure 0.4985 to

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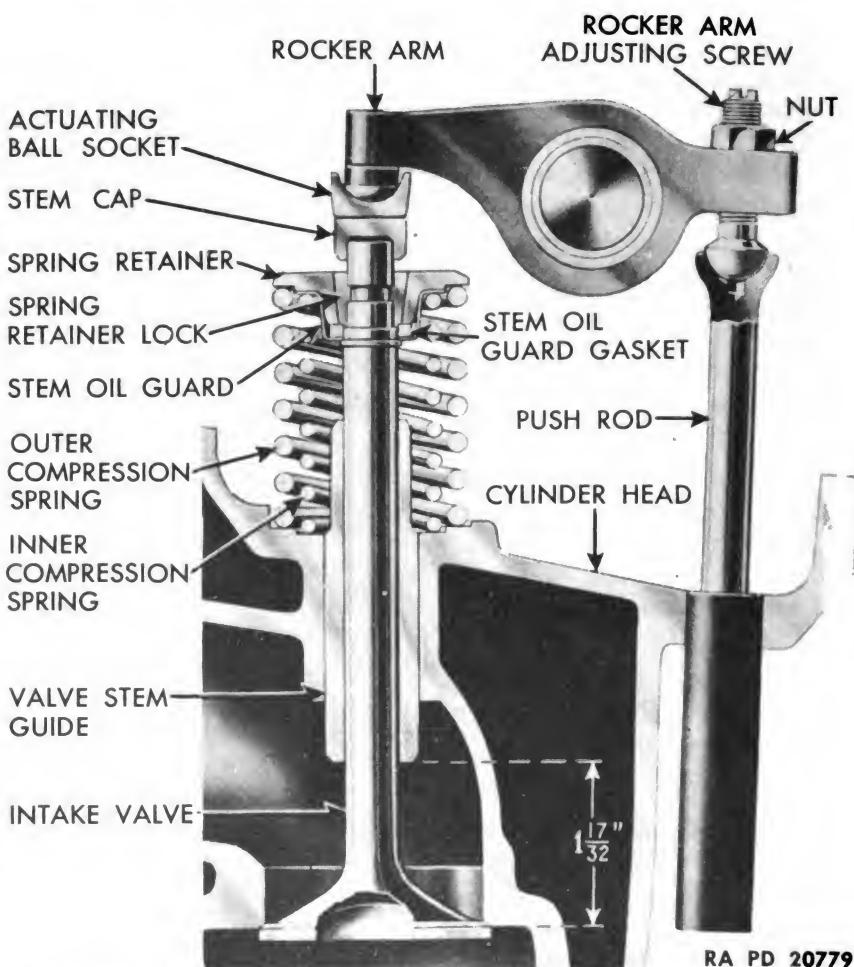


Figure 47 — Cross-Section of Intake Valve Assembly

0.4990 inches. Refer to subparagraph d (3) below for replacement of worn valve guides.

d. Rebuild (Recondition).

(1) **CYLINDER HEAD.** Replace all broken, bent or damaged studs. Smooth all nicked or burred machined surfaces with a file. Recondition seats with a valve seat grinder. The angle of intake valve seat is 30 degrees, and exhaust valve seat angle is 45 degrees. Exhaust valve seats have hardened inserts. If inserts are cracked or worn excessively, they must be replaced. Refer to subparagraph d (4) below for replacement of valve seat inserts.

(2) **VALVES.** Reface the valves on a valve-refacing machine. The angle on intake valve face is 30 degrees. The angle of the exhaust valve face is 44 degrees. *NOTE: This is 1 degree different from the exhaust valve seat angle in the head, and is termed an interference angle. At high temperatures it provides a better seal than a valve seat and valve face machined at the same angle.*

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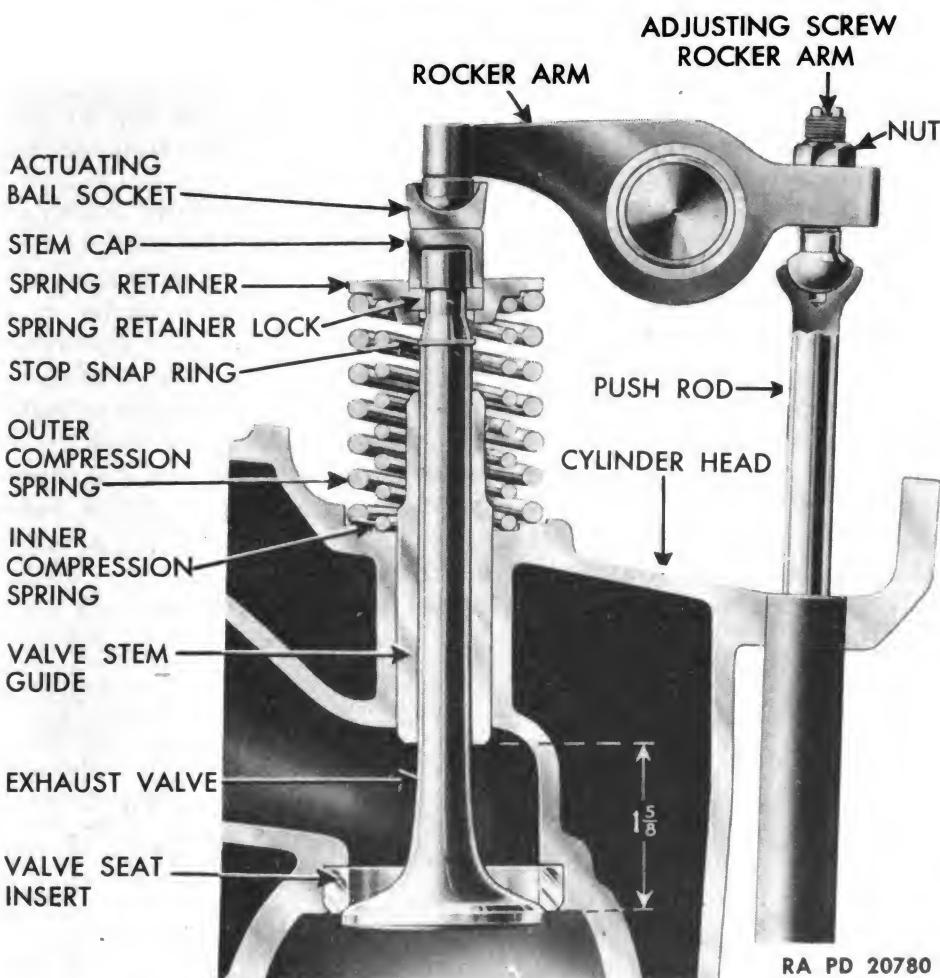


Figure 48 — Cross-Section of Exhaust Valve Assembly

(3) **VALVE GUIDES.** Place head bottom side up, supported by a piece of wood at each end. Drive old guides out with a $\frac{7}{8}$ -inch drift. Replace new guides with same drift. Drive intake guide in until end of guide is $1\frac{7}{32}$ inches from face of valve seat (fig. 47). The exhaust valve guide is driven in until end is $1\frac{5}{8}$ inches from valve seat (fig. 48). After installing guides, ream to 0.4985 to 0.4990 inches. Valve seats should always be refinished after new guides are installed. Refer to step (1) above for refinishing of valve seats.

(4) **VALVE SEAT INSERTS.** Remove cracked or worn inserts with a valve seat puller. Ream insert recess to receive 0.010-inch oversize insert. NOTE: A standard insert should never be used as a replacement insert, as it will not remain tight in service. The recess should be reamed to 2.1980 to 2.1985 inches for 0.010-inch oversize insert. Place new insert in dry ice for several minutes. The chilling of insert will reduce its diameter, and permit it to be driven into recess. Drive insert carefully into place with driver of

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proper size. Make certain that insert is seated firmly in bottom of recess. Roll or crimp edge of recess over top edge of insert. Grind valve seat to correct 45-degree angle.

e. Assemble. Place valves in cylinder head, and lap in place. If valve refacing (subparagraph d (2)) and valve seat grinding (subparagraph d (1)) have been done properly, very little lapping will be necessary. After lapping, rub a very thin coating of Prussian blue paste in oil on the valve face, and bounce valve on its seat to check for effective seating. Place valve stop snap rings in place in valve stem groove. Place valve springs, retainers, and locks in position on valves (figs. 47 and 48). *NOTE: The exhaust valve retainers are much thinner than intake retainers and have a straight recess for the lock, whereas intake retainers have a tapered recess for lock. The exhaust valve retainer locks are thinner than intake locks and have parallel sides, whereas intake locks are tapered.* Assemble oil guards and new oil guard gaskets on intake valves. Place valve lifter (41-L-1408) in position (subparagraph a above). Depress lifter lever and insert locks in proper position. Release lifter lever, and remove lifter. Repeat operation for other 11 valves.

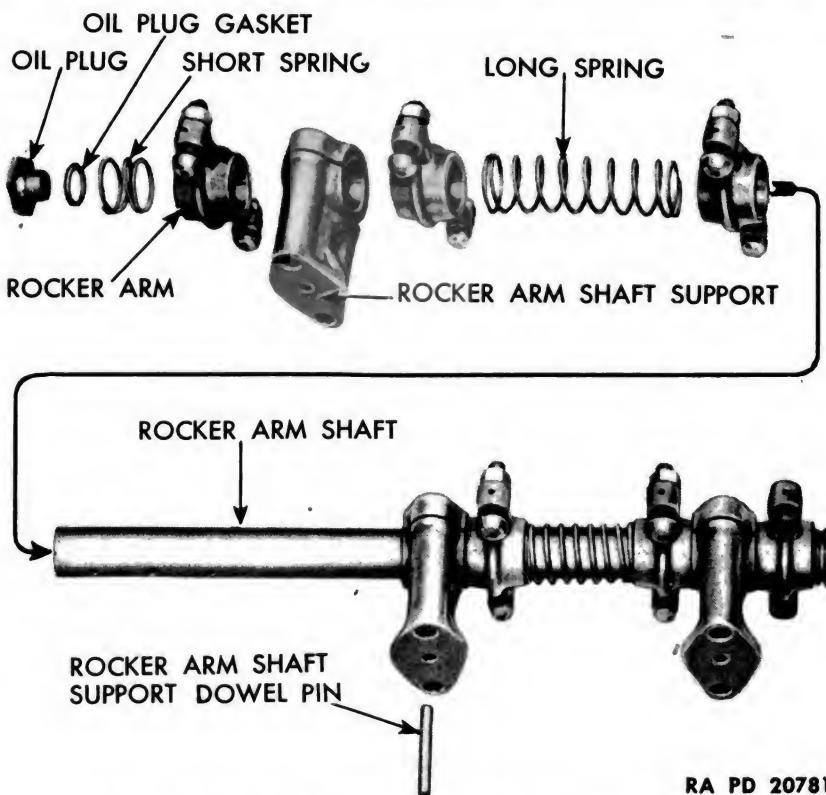


Figure 49 — Rocker Arm Shaft Components

9. ROCKER ARMS AND ROCKER ARM SHAFT.

a. Disassemble. Remove hexagonal-headed oil plug screwed into each end of rocker arm shafts (fig. 49). Slide two short springs,

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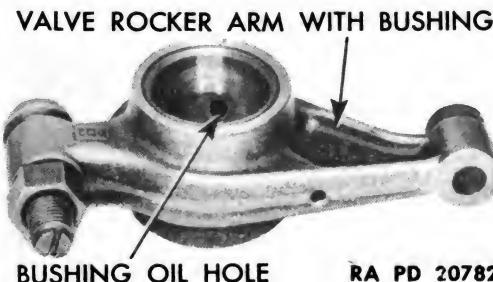
two long springs, three rocker arm supports, and six rocker arms from shaft (fig. 49).

b. Clean. Clean all parts of rocker arm shaft assembly in dry-cleaning solvent.

c. Inspect.

(1) **ROCKER ARM SHAFTS.** Examine rocker arm shafts for wear. If shafts show signs of wear, check with micrometers. A new shaft measures 0.9680 to 0.9687 inches.

(2) **ROCKER ARMS.** Measure rocker arm bushing with a plug gage. New bushings measure 0.9687 to 0.9692 inch. Refer to subparagraph d (1) below for replacing worn bushings. Examine valve actuating ball for wear. Refer to subparagraph d (2) below for replacement of worn ball. Examine tappet adjusting screw and nut. If worn or damaged, replace screw and nut.



**Figure 50 — Lining Up
Bushing Oil Hole
in Valve Rocker Arm**

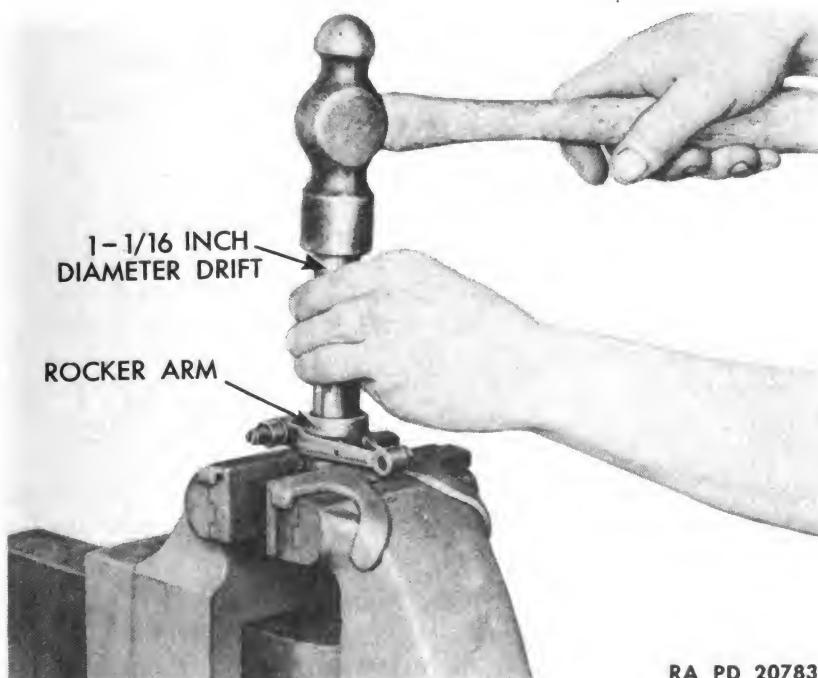
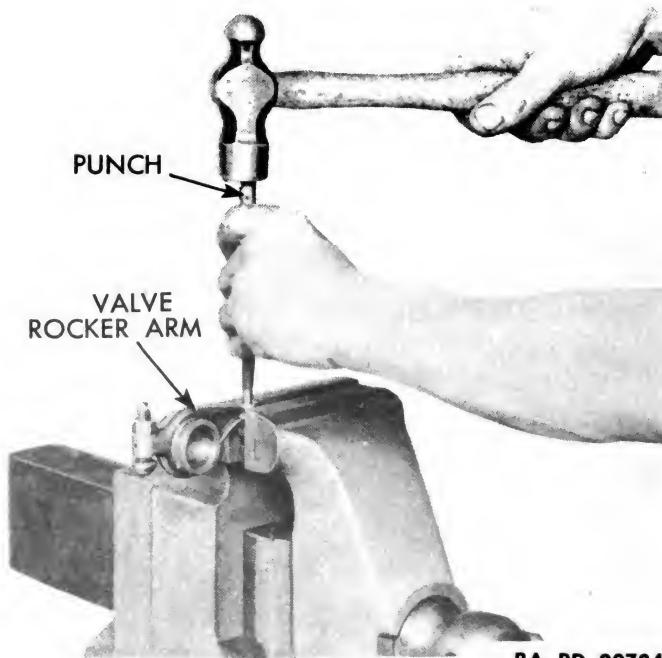


Figure 51 — Removing Valve Rocker Arm Bushing

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(3) **ROCKER ARM SHAFT SUPPORTS.** Examine supports for cracks.

(4) **ROCKER ARM SHAFT SPRINGS.** Measure free length of rocker arm shaft springs. Long spring should measure $3\frac{3}{4}$ inches. Short spring should measure $2\frac{3}{32}$ inch.



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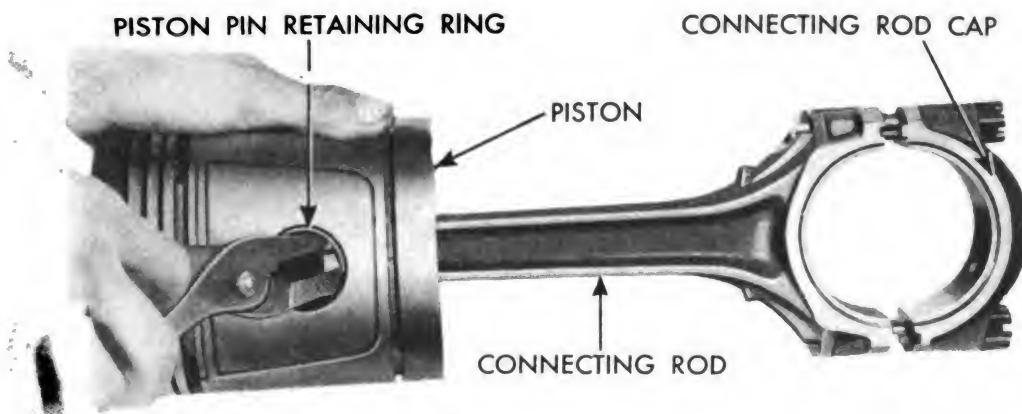
Figure 52 — Removing Valve Rocker Arm Ball

d. Repair.

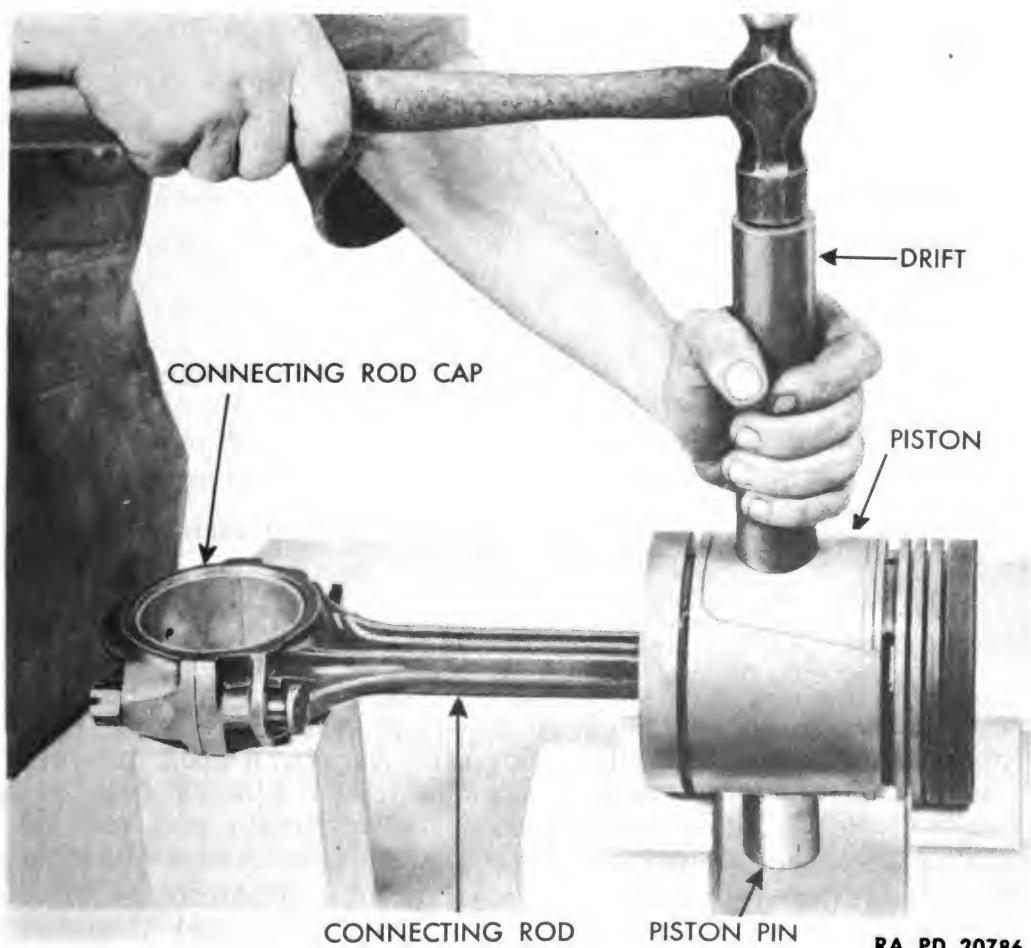
(1) **ROCKER ARM BUSHING.** With a punch, make a mark on edge of bushing hole in rocker arm, directly in line with oil hole in bushing (fig. 50). Using a $1\frac{1}{16}$ -inch drift, drive out bushing (fig. 51). Drive in new bushing with same drift, making certain that oil hole in bushing is exactly in line with punch mark on rocker arm. **NOTE:** *One end of bushing hole in rocker arm is chamfered.* The bushing must be driven in from chamfered side. Ream bushing to 0.9687 to 0.9692 inch.

(2) **ROCKER ARM BALL.** Place rocker arm in a vise, and drive out rocker arm ball (fig. 52). Drive in serviceable ball with a lead hammer.

e. Assemble. Assemble plug with new gasket at one end of one rocker arm shaft (fig. 49). Assemble rocker arms, springs, and supports on shaft in the order shown in figure 49. Assemble plug with new gasket at other end of shaft, and tighten. Use same procedure to assemble other rocker arm shaft.

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Figure 53 — Removing Piston Pin Retaining Ring

RA PD 20786

Figure 54 — Removing Piston Pin

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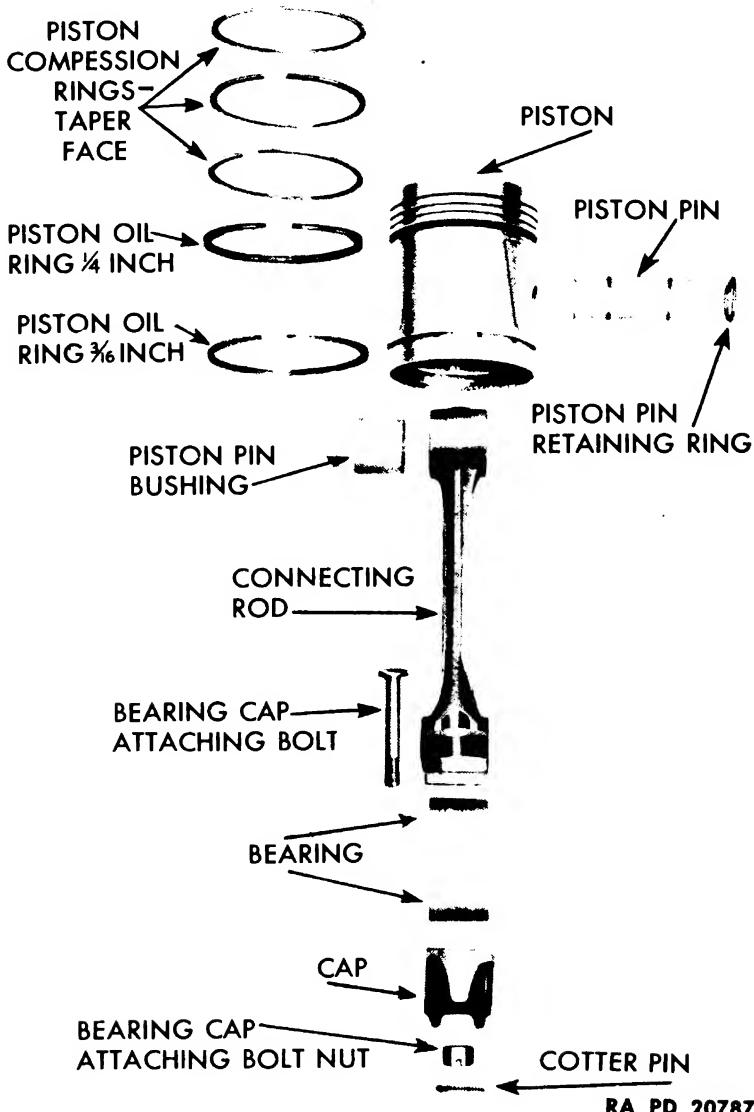


Figure 55 — Piston and Connecting Rod Components

10. CONNECTING RODS AND PISTONS.

a. **Disassemble.** Remove piston rings with a piston ring remover and replacer. Remove two piston pin retaining rings from piston pin hole in piston (fig. 53). Support piston on wood blocks, and drive out piston pin with 1 3/8-inch drift (fig. 54). Remove nuts and bolts attaching cap to connecting rod, and lift off cap. Tap rod and cap on piece of wood to knock out bearing.

b. **Clean (fig. 55).** Clean all parts with dry-cleaning solvent, and dry with compressed air. Scrape carbon from head of piston. Clean ring grooves with piece of piston ring ground to a chisel edge, or with a groove-cleaning tool.

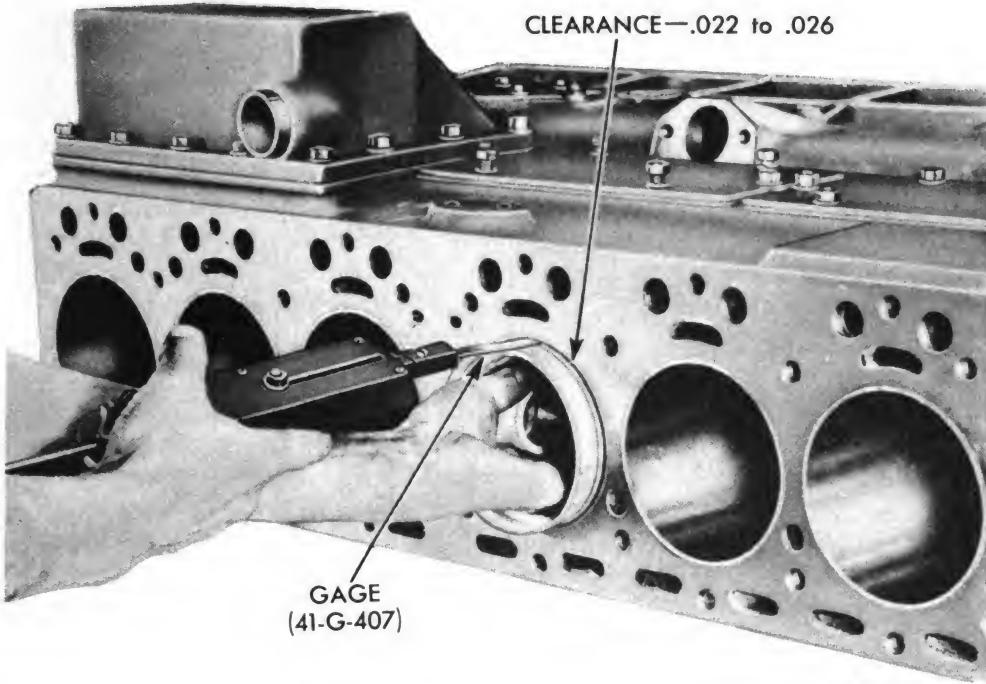
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Figure 56 — Checking Piston Fit in Cylinder Block, Using Thickness Gage

c. Inspect.

(1) PISTONS. Check pistons carefully for cracks or other damage. With a suitable plug gage, check piston pin hole. Hole in new piston measures 1.4998 to 1.5000 inches. The piston is tapered and oval-ground. It should be checked by inserting it into the cylinder block with a 0.007-inch thickness gage (41-G-407) attached to a spring scale (fig. 56). The gage should pull out with a scale reading of 10 to 15 pounds.

(2) CONNECTING RODS. Inspect connecting rods carefully for cracks, nicks, or burs. Check for straightness, and discard rods that are bent. Check piston pin bushing with a suitable plug gage. Bushing should measure 1.5003 to 1.5005 inches.

(3) PISTON PINS. Inspect pins for nicks or burs. Measure diameter with a micrometer. New standard pins measure 1.4998 to 1.5000 inches.

d. Repair.

(1) PISTONS. Pistons that are in good condition except for pin fit may be reconditioned by fitting oversize piston pins. Piston pins 0.003 and 0.005 inch oversize are supplied. For 0.003-inch oversize pin, hone piston pin hole to 1.5028 to 1.5030 inches. For 0.005-inch oversize piston pin, hone piston pin hole to 1.5048 to 1.5050 inches. When oversize pins are used, bushing in connecting rod must be honed as described in step (2) following.

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(2) CONNECTING RODS. If old pistons are being used with oversize piston pins, hone pin bushing to 1.5033 to 1.5035 inches for 0.003-inch oversize piston pins. For 0.005-inch oversize pins, hone bushing to 1.5053 to 1.5055 inches. When new pistons are installed and piston pin bushings are worn, install new piston pin bushings and new standard piston pins. With a suitable size drift, drive out piston pin bushing. Press in new bushing with two oil holes at right angles to rod, and with open ends of inside oil grooves toward top of rod. Hone bushing to 1.5003 to 1.5005 inches. Piston pin should be 0.0003 inch loose in connecting rod piston pin bushing.

e. Assemble. Heat piston in water to approximately 160°F. Position piston over rod so that piston pin hole in rod lines up with hole in piston. Push piston pin into place, and install new piston pin lock rings (fig. 53). Place piston rings in their proper grooves (fig. 55), using a piston ring removing and replacing tool.

CAUTION: *Always use new rings when installing new pistons. Be sure to install compression rings with side marked "TOP" toward head of piston.*

11. CRANKSHAFT.

a. Clean. Wash crankshaft in dry-cleaning solvent, and dry off with compressed air. Clean all oil holes with wire brush.

b. Inspect. Inspect all journals for cuts and scores. Examine flywheel flange and front end of shaft for nicks and burs. Check the main and connecting rod journals with a micrometer. The crankshaft bearing journal diameter of a new crankshaft is 3.249 to 3.250 inches. Connecting rod journal diameter is 2.999 to 3.000 inches. Check the diameter of the journals at the ends and the middle for taper, and at several points around the shaft for out-of-round. Journals that are out-of-round, tapered more than 0.003 inch, or badly worn or scored, should be reground. Refer to subparagraph c below, for grinding.

c. Repair. Crankshaft bearings are supplied in 0.010 inch undersize, and connecting rod bearings 0.010 and 0.020 inch undersize. When using 0.010 inch undersize crankshaft bearings, grind shaft from 3.239 to 3.240 inches. The desired size is 3.2395 inches. For 0.010 inch undersize connecting rod bearings, grind the shaft from 2.989 to 2.990 inches. The desired size is 2.9895 inches. For 0.020-inch undersize rod bearings, grind shaft 2.979 to 2.980 inches. The desired size is 2.9795 inches.

12. FLYWHEEL.

a. Clean. Clean flywheel with dry-cleaning solvent, and dry with compressed air.

b. Inspect. Check crankshaft flange contact face of flywheel for nicks or other damage. Examine ring gear for worn or broken teeth. If ring gear is damaged, refer to subparagraph c (1) below

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for replacement. Examine nine clutch studs for damage. Check condition of six flywheel dowel pins. Inspect clutch surface for scores and heat checks. Refer to subparagraph c (2) following for refinishing clutch face.

c. Rebuild.

(1) **RING GEAR.** Drive old ring gear off with a drift and hammer. Place the flywheel, clutch side down; on a bench. Heat new ring gear evenly all around to 560°F to 570°F. Place on flywheel with chamfered side of teeth upward. Drive ring gear onto flywheel until it fits tightly up against the shoulder on flywheel all around. Let the ring gear cool in air.

(2) **FLYWHEEL.** Mount flywheel with damaged clutch surface on a lathe, after removing clutch studs. Take a very fine cut off the entire rear face of the flywheel. NOTE: *Cut just deep enough to smooth the clutch surface.* Polish clutch surface. Reinstall clutch studs, allowing them to extend 2 inches from clutch face of flywheel. Use new studs if old ones are bent, or have damaged threads. Replace any damaged flywheel dowel pins.

13. FLYWHEEL HOUSING.

- a. **Clean.** Wash flywheel housing with dry-cleaning solvent, and dry with compressed air.
- b. **Inspect.** Inspect all surfaces for cracks, and discard cracked housings. Check machined surfaces for nicks or burs.
- c. **Repair.** Smooth down nicks or burs on machined surfaces with a file.

14. TIMING GEARS.

- a. **Clean.** Wash gears with dry-cleaning solvent, and dry with compressed air.
- b. **Inspect.** Examine all surfaces for nicks and burs. Inspect teeth for wear, and replace all gears if any teeth are worn.
- c. **Repair.** With a fine file, smooth nicks on face and teeth of gears.

15. FRONT END PLATE.

- a. **Clean.** Strip off gaskets and sealing compound. Wash plate with dry-cleaning solvent, and dry with compressed air.
- b. **Inspect.** Check plate for flatness. Replace plate if badly bent. If slightly bent, refer to subparagraph c following for repair. Inspect all surfaces for nicks or burs.
- c. **Repair.** Place slightly bent plate on a flat surface, and straighten with a rawhide mallet or lead hammer. Smooth all nicks and burs with a fine file.

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16. TIMING GEAR COVER.

- a. **Clean.** Strip off all gaskets and sealing compound. Remove felt seal in crankshaft bore. Wash cover with dry-cleaning solvent, and dry off with compressed air.
- b. **Inspect.** Examine all surfaces for cracks. Replace cracked cover. Inspect all machined surfaces for nicks and burs. Check condition of oil seal, and replace if worn or damaged. Refer to subparagraph c below for replacement.
- c. **Repair.** Smooth all nicks and burs with a fine file. To replace damaged seal, place gear cover, with crankcase contact surface up, on bench, and drive out oil seal with drift and hammer. Turn cover over, and drive new seal into place with the edge or lip of the leather facing down.



Figure 57 — Removing Oil Pan Handhole Cover

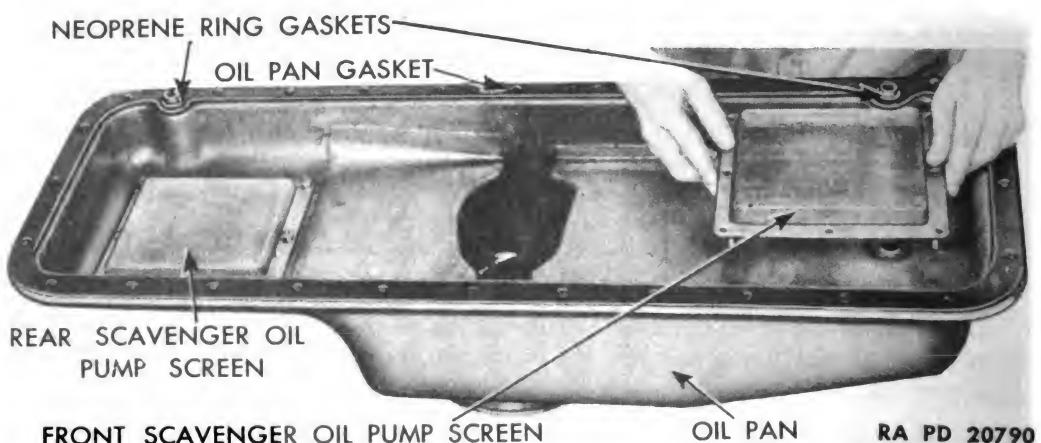


Figure 58 — Removing Scavenger Oil Pump Screen

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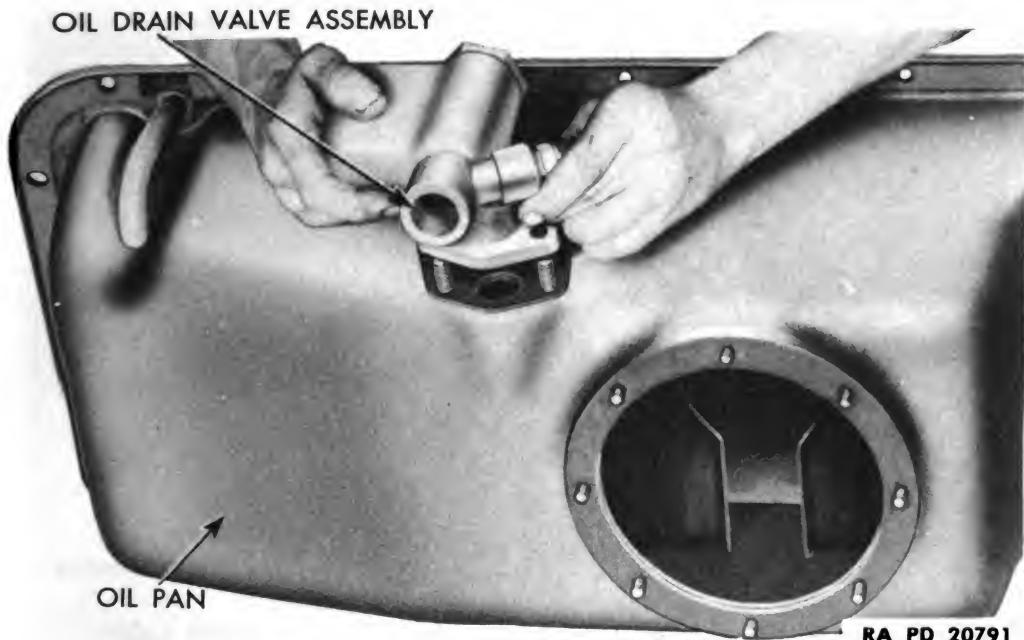


Figure 59 — Removing Oil Drain Valve Assembly

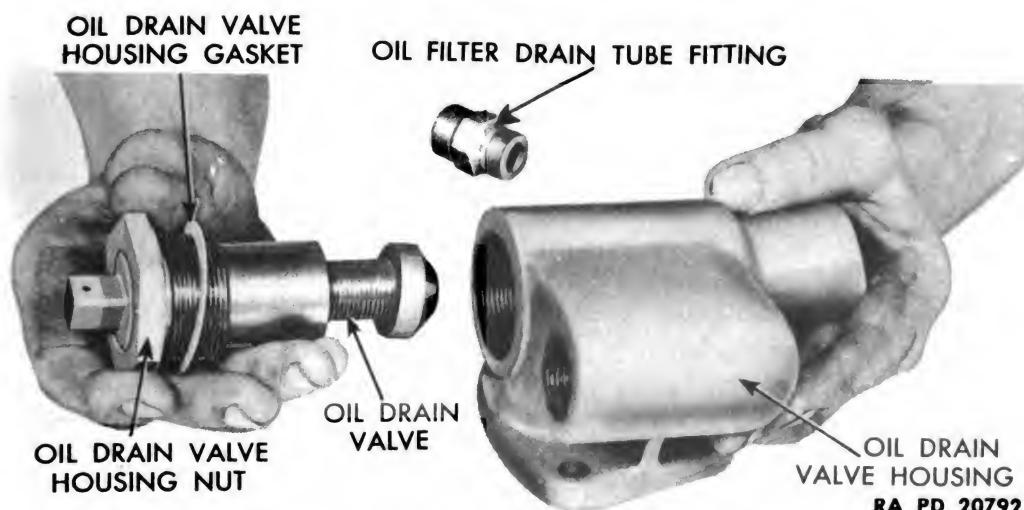


Figure 60 — Removing Oil Drain Valve From Oil Drain Valve Housing

17. OIL PAN.

a. **Disassemble.** Remove eight nuts and lock washers, and lift off hand-hole cover (fig. 57). Remove eight nuts and lock washers, and lift off front scavenger oil pump screen (fig. 58). Use same procedure to remove rear screen. Remove four nuts and lock washers, and lift off oil drain valve assembly (fig. 59). Remove oil drain valve from housing (fig. 60). Remove oil drain valve from housing nut (fig. 61).

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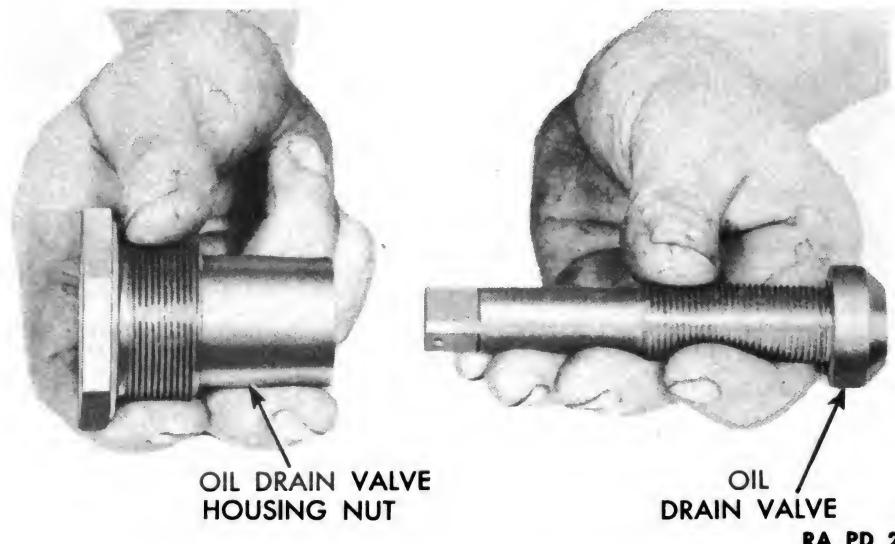


Figure 61 — Removing Oil Drain Valve Housing Nut From Valve

b. Clean.

- (1) **OIL DRAIN VALVE.** Strip off gasket and sealing compound from oil drain valve body. Clean all parts with dry-cleaning solvent.
- (2) **OIL PAN.** Strip off all gaskets and sealing compound. Clean inside and out with dry-cleaning solvent, and dry with compressed air.
- (3) **SCAVENGER OIL PUMP SCREENS.** Clean screens with dry-cleaning solvent, and dry with compressed air.

c. Inspect.

- (1) **OIL DRAIN VALVE.** Inspect all surfaces of oil drain valve body for cracks. Replace cracked body. Check condition of threads in three tapped holes. Check condition of valve seat in body. Inspect threads and face of oil drain valve. Inspect threads and oil seal in valve retaining nut. If seal is damaged, refer to subparagraph d (1) for replacement.
- (2) **OIL PAN.** Inspect all surfaces on pan for cracks and dents.
- (3) **SCAVENGER OIL PUMP SCREENS.** Inspect screens for holes and other damage. Damaged screens should be replaced.

d. Repair.

- (1) **OIL DRAIN VALVE.** Drive oil seal out of valve housing nut. Drive new seal in with edge or lip of seal facing down (fig. 62).
- (2) **OIL PAN.** Braze small cracks in oil pan. Do not attempt to braze large holes or cracks.

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Figure 62 —

*Installing Oil Seal
in Oil Drain Valve
Housing Nut*

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(3) SCAVENGER OIL PUMP SCREENS. Straighten screens with the fingers. If frame is bent, place screen on flat surface, and straighten with a hammer.

e. Assemble.

(1) OIL DRAIN VALVE. Assemble valve housing nut on drain valve (fig. 61). Using a new copper-asbestos gasket, screw the housing nut with valve into the oil drain valve housing (fig. 60) and tighten it.

(2) OIL PAN. Shellac a new gasket on the oil pan drain valve assembly. Mount the oil drain valve assembly on the four studs on the side of the oil pan with four lock washers and nuts (fig. 59). Tighten all four nuts evenly. Shellac a new gasket on oil pan hand-hole cover. Install cover on oil pan with eight lock washers and nuts (fig. 57). Tighten nuts evenly. Assemble the two scavenger oil pump screens to their studs inside the oil pan with 16 lock washers and nuts, and tighten (fig. 58).

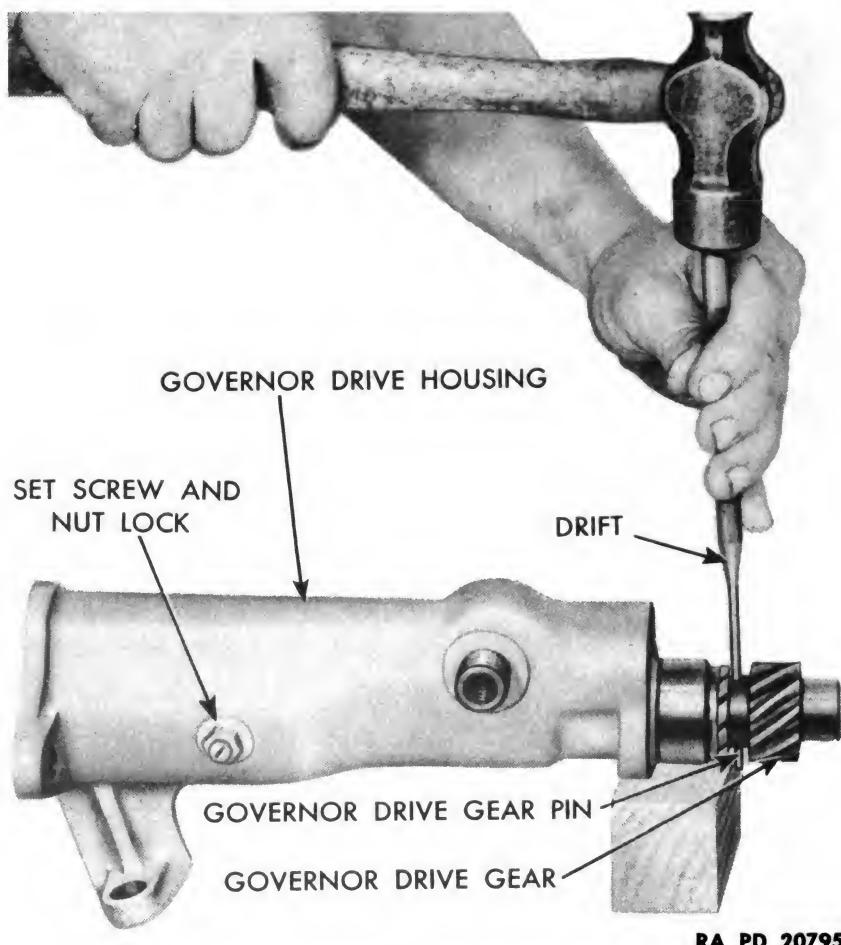
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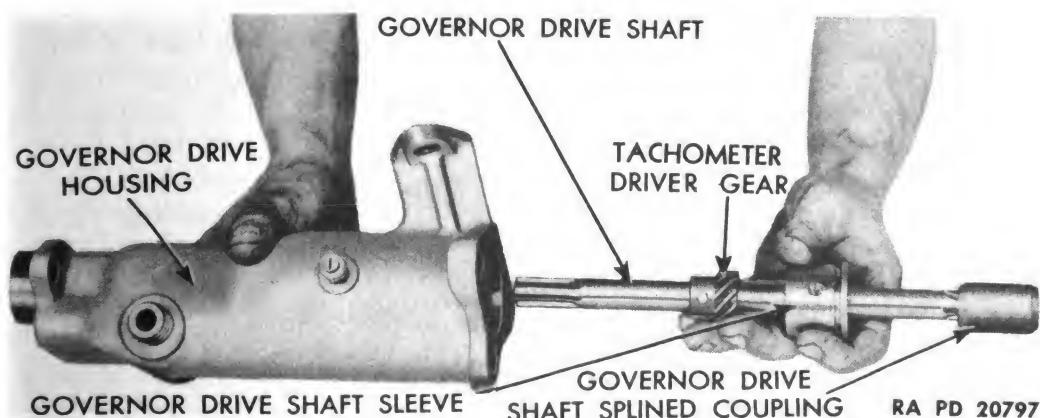
Figure 63 — Removing Governor Drive Gear Pin

18. GOVERNOR DRIVE HOUSING ASSEMBLY.

- Disassemble. Unscrew tachometer gear bearing retainer, and pull out tachometer drive assembly (fig. 66). Loosen set screw and lock nut in housing (fig. 66). With a $\frac{1}{8}$ -inch drift, drive out pin holding governor drive gear to shaft (fig. 63). With a drift, drive governor drive shaft out of housing (fig. 64). Remove sleeve and splined coupling from upper end of shaft (fig. 65).
- Clean. Strip off gaskets and sealing compound from drive shaft housing, and wash all parts with dry-cleaning solvent.
- Inspect. Inspect drive housing for cracks. Replace housing if cracked. New bushings measure 0.624 to 0.625 inch. Refer to subparagraph d for replacing bushings. Inspect threads at both ends of tachometer drive hole for damage. Inspect ball bearing in tachometer drive hole, and replace if worn or damaged. Check governor drive shaft for wear. New shaft measures 0.6225 to 0.6230 inch. Replace if worn. Check condition of teeth on both

DISASSEMBLY, CLEANING, INSPECTION, REPAIR, AND ASSEMBLY OF SUBASSEMBLIES**Figure 64 —****Removing Governor****Drive Gear**

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**Figure 65 — Removing Governor Drive Shaft Assembly**

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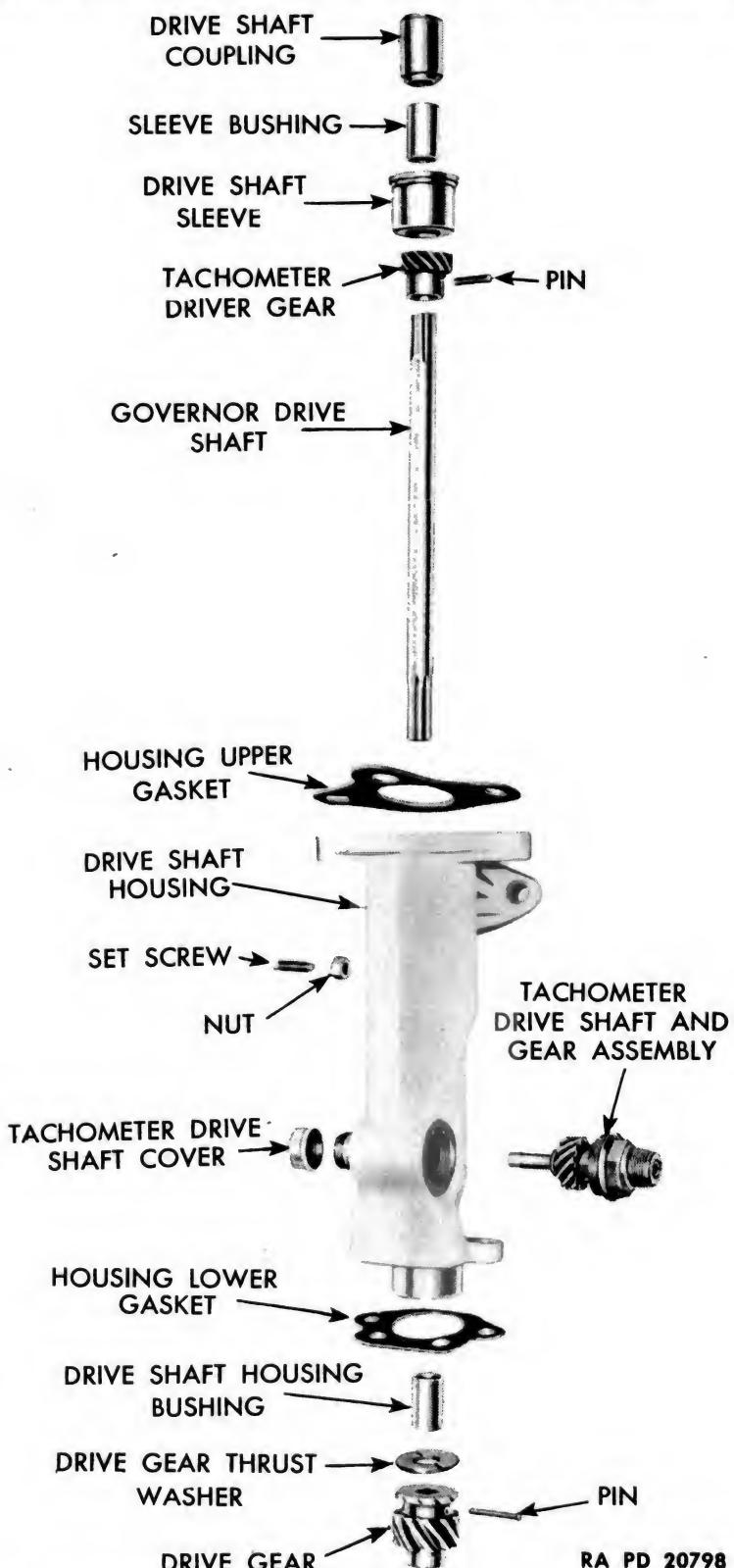


Figure 66 — Governor Drive Shaft Assembly Components

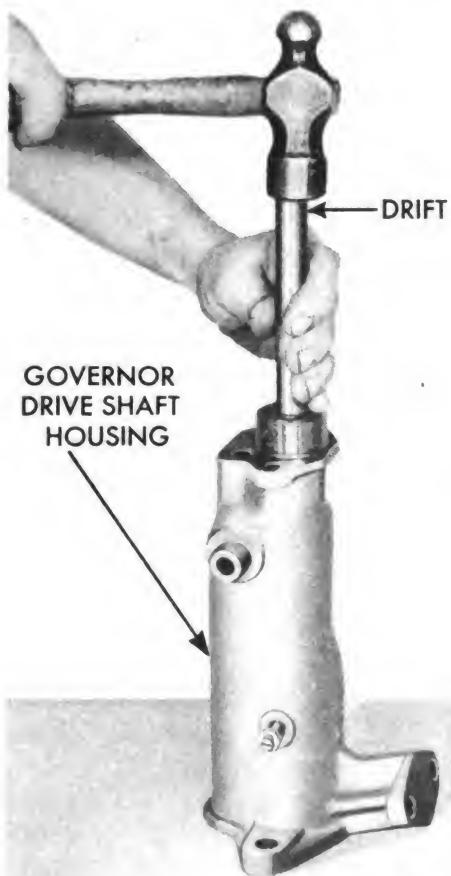
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Figure 67 —
Removing
Governor Drive Shaft
Housing Bushings

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the governor drive and tachometer driver gears. If gears are worn or chipped, replace. Check bushing in governor drive shaft sleeve. New bushing measures 0.624 to 0.625 inch. If worn, replace. Inspect tachometer drive shaft bearing and oil seal in retainer. Replace if worn.

d. **Repair.** Drive old bushings out with $\frac{3}{4}$ -inch drift (fig. 67). Drive two new bushings into place from bottom end of housing. First bushing is driven in until its inner end is flush with top of bushing bore. Drive second bushing in until its outer end is flush with bottom of housing. Ream bushings to 0.624 to 0.625 inch.

e. **Assemble.** Insert governor drive shaft into housing with end having longest spline at the bottom (fig. 65). Slide shaft sleeve over shaft at upper end, and into upper end of housing. Before pushing sleeves into place, line up set screw seat on sleeve with tapped hole for set screw in housing. Insert set screw (fig. 66), and tighten. Assemble set screw lock nut on set screw, and tighten. Assemble thrust washer on lower end of governor drive shaft. Press governor drive gear onto shaft, with thrust face of gear next to thrust washer, and with pin hole in hub of gear in line with pin hole in shaft. Drive a $\frac{5}{32} \times 1\frac{1}{4}$ -inch straight pin through pin holes in shaft and gear,

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and rivet both ends. If a new shaft is used, it will be necessary to drill through with a $\frac{5}{32}$ -inch drill. Before drilling, make sure that tachometer driver gear is snug against top face of bearing bore in housing, and place a 0.006-inch thickness gage between thrust washer and gear. This will assure having the correct end play of 0.006 to 0.008 inches. Press governor coupling on upper end of governor drive shaft. Insert tachometer drive shaft assembly in tachometer drive hole, and assemble bearing retainer with new gasket to governor drive housing. Draw bearing retainer up tight.

19. CYLINDER HEAD VALVE COVERS.

- a. **Clean.** Strip off gaskets and sealing compound. Wash covers inside and out with dry-cleaning solvent.
- b. **Inspect.** Inspect all surfaces for cracks and dents. Replace badly cracked or dented covers. Check condition of tapped holes.
- c. **Repair.** Small cracks can be welded or brazed. Small dents can be removed with a hammer.

20. VALVE TAPPETS.

- a. **Clean.** Wash tappets with dry-cleaning solvent.
- b. **Inspect.** Measure diameter of tappet stem. New tappets measure 0.6082 to 0.6087 inch. Replace worn tappets. Inspect face of tappet. If badly worn replace tappet. If face of tappet is slightly worn, refer to subparagraph c following for repair.
- c. **Repair.** Place a piece of crocus cloth on a surface plate. Holding face of tappet on crocus cloth, polish with a circular motion until all marks are removed from face of tappet. After polishing, clean tappet in dry-cleaning solvent.

21. VALVE TAPPET GUIDES

- a. **Clean.** Clean tappet guides in dry-cleaning solvent.
- b. **Inspect.** Check inside diameter of valve tappet guides. New guides measure 0.6089 to 0.6101 inch. Replace worn guides.

22. VALVE TAPPET COVERS.

- a. **Clean.** Strip off gaskets and sealing compound. Wash with dry-cleaning solvent.
- b. **Inspect.** Check covers with a straight edge, and replace covers that are warped or sprung.

23. VALVE PUSH RODS.

- a. **Clean.** Clean push rods with dry-cleaning solvent.
- b. **Inspect.** Examine ball and socket ends for wear, and replace worn rods. Check rods for straightness. Replace bent push rods.

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24. OIL COOLER.

- a. Clean. Strip gaskets and sealing compound from both sides of oil cooler plate. Clean inside and out with dry-cleaning solvent. Blow out inside of cooler with compressed air.
- b. Inspect. Check mounting plate, and remove nicks and burs with a fine file. Check condition of two studs, and replace if damaged. Fill cooler with dry-cleaning solvent and check for leaks. Discard cooler with large holes. Refer to subparagraph c for repair of small holes.
- c. Repair. Repair small pin holes by soldering or brazing. After soldering or brazing, test cooler for leaks (subparagraph b above).

25. OIL FILTER AND COOLER BASE.

- a. Clean. Strip off gaskets and sealing compound. Clean inside and out with dry-cleaning solvent. Blow out all oil holes with compressed air.
- b. Inspect. Examine all surfaces for cracks. Replace if cracked.

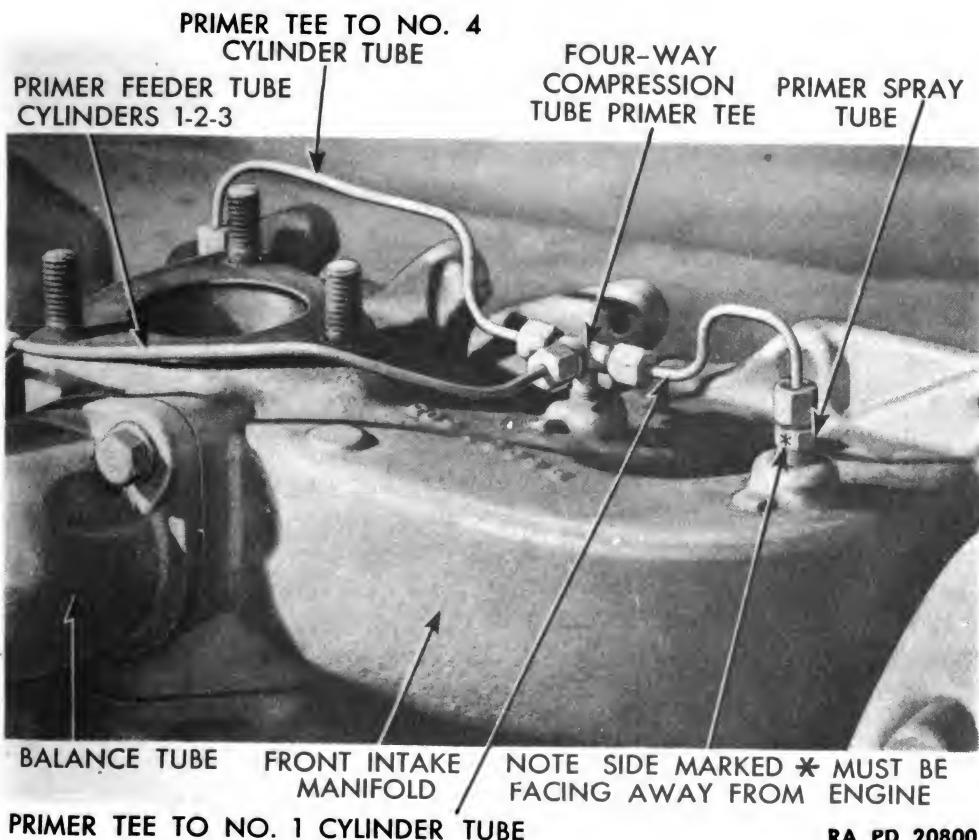
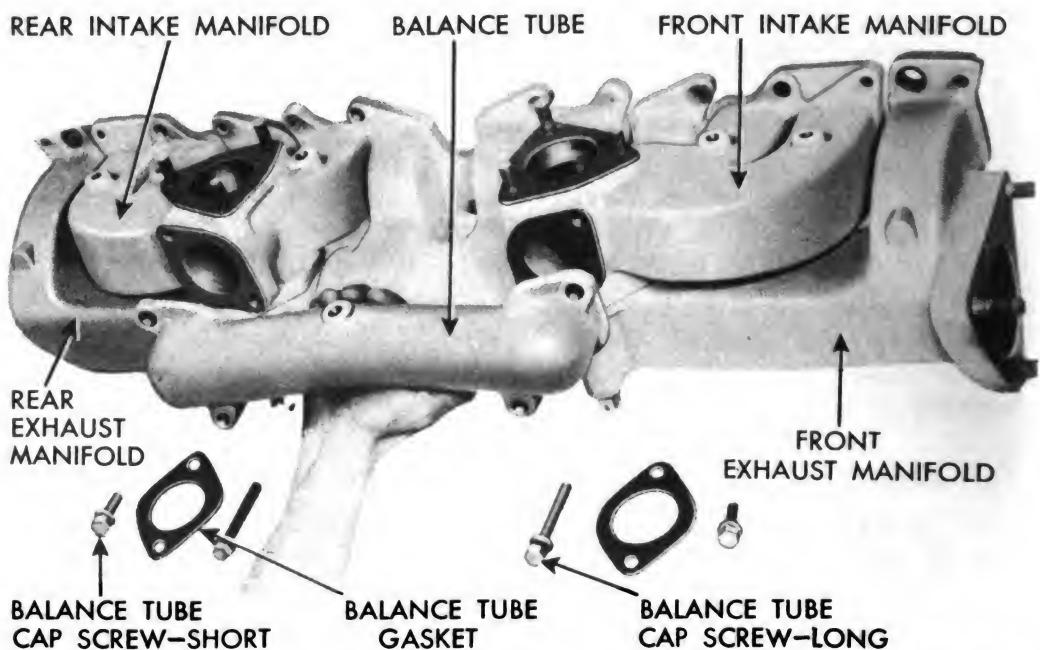


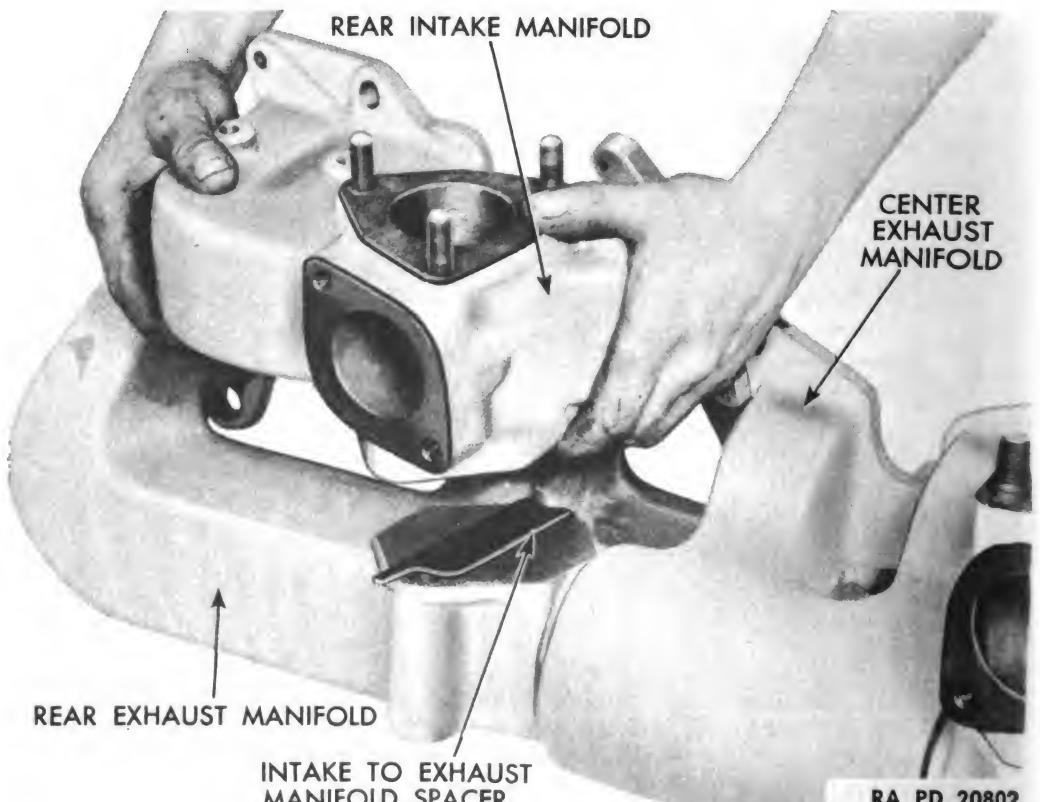
Figure 68 — Installation of Primer Tubes and Tees

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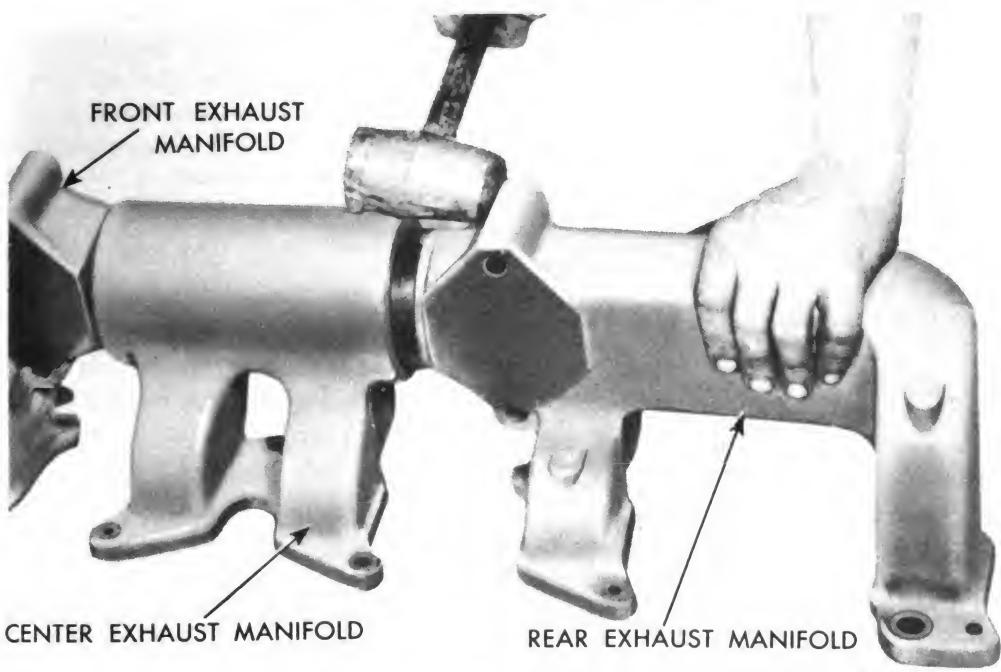
RA PD 20801

Figure 69 — Removal of Intake Manifold Balance Tube



RA PD 20802

Figure 70 — Removing Intake Manifold

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RA PD 20803

Figure 71 — Separating Exhaust Manifolds

26. INTAKE AND EXHAUST MANIFOLDS.

a. **Disassemble.** Remove 12 nuts holding the 6 primer tubes to the primer tubes with tees. Pull off primer tubes. Remove seven primer tubes with tees (fig. 68). Remove four cap screws and lock washers holding balance tube to manifold. Lift off balance tube (fig. 69). Cut lock wire, and remove two cap screws and lock washers holding rear intake manifold to exhaust manifold. Lift off rear intake manifold and spacer (fig. 70). Repeat operations to remove front intake manifold. Separate three exhaust manifold sections by tapping with a mallet or lead hammer (fig. 71).

b. **Clean.** Strip off all gaskets. Wash all parts inside and out with dry-cleaning compound. Blow out insides of manifolds with compressed air.

c. **Inspect.** Examine all surfaces for cracks. Replace all cracked parts. Check surfaces of cylinder head contact faces of the exhaust manifold for warpage. If warped more than 0.006 inch, replace. Examine governor studs on intake manifolds, and exhaust outlet studs on front exhaust manifold for damage. Replace all damaged studs.

d. **Assemble.** Place center section of exhaust manifold on a bench with cylinder contact surface down. Place front section in same position, and start turned portion of front section into bore of center section. Tap two sections together with a mallet or soft hammer. Repeat operation to assemble rear section. Place two

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intake manifolds in position, and assemble with four cap screws and lock washers. Before drawing intake manifolds up to the exhaust manifold, insert two spacers between intake manifolds and exhaust manifold (fig. 70). NOTE: *Draw intake manifolds up snug to the exhaust manifold, but do not tighten.* Using new gaskets, assemble balance tube to intake manifolds with four lock washers, two short cap screws, and two long cap screws (fig. 69). NOTE: *Do not tighten screws, but draw them up snug.*

27. WATER INLET HEADER.

- a. **Clean.** Strip off gaskets and sealing compound. Wash with dry-cleaning solvent inside and out. Blow out with compressed air.
- b. **Inspect.** Examine all surfaces for cracks. Replace cracked headers. Inspect all studs, and replace damaged studs.

28. WATER OUTLET HEADER.

- a. **Disassemble.** Remove five cap screws and lock washers holding thermostat housing to outlet manifold. Lift off thermostat housing. Lift out four thermostats.
- b. **Clean.** Strip off gaskets and sealing compound. Wash all parts in dry-cleaning solvent. Blow out header with compressed air.
- c. **Inspect.** Examine all surfaces of outlet header and thermostat housing for cracks. Replace cracked parts. Examine thermostats for damage. Replace damaged thermostats. If thermostat valve is in an open position at room temperature, it indicates that the bellows have failed. Replace defective thermostats.
- d. **Assemble.** Place header, right side up, on bench. Place four thermostats in position in counterbores in header, with word "FRONT" stamped on rim of thermostat facing front end of header. Place four new rubber thermostat seals in position on thermostats. Shellac a new gasket on housing, and place housing in position on header. Assemble and tighten five lock washers and screws.

29. PRIMER TUBES.

- a. **Clean.** Wash primer tubes and fittings in dry-cleaning solvent. Blow out tubes and fittings with compressed air. Make certain that jet holes near bottom ends of primer fittings are free of dirt.
- b. **Inspect.** Examine threads of fittings and replace fittings having damaged threads. Examine primer tubes. Replace cracked or pinched tubes.

30. CAMSHAFT.

- a. **Clean.** Wash camshaft with dry-cleaning solvent. Blow

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off with compressed air. Clean out oil holes at front end with a wire brush.

b. Inspect. Examine all cams and journals for scores. Replace badly scored shaft. Light scores on the cams can be honed (sub-paragraph c below). Check all journals with a micrometer. New journals measure 2.1220 to 2.1225 inches.

c. Repair. Using a fine whetstone, carefully hone small scores or scratches on the cams. Hone around the circumference, not across the face of the cam. Do not attempt to remove deep scores

31. DAMPER.

a. Clean. Wash damper with dry-cleaning solvent and dry off immediately with compressed air, so as not to damage the rubber that bonds the two metal parts of the damper together.

b. Inspect. Examine the rubber bonding carefully. If separation is evident between rubber and metal, replace the damper. Check attaching flange of damper for damage. If sprung, replace damper.

32. FRONT ENGINE SUPPORT.

a. Clean. Wash support with dry-cleaning solvent, and dry with compressed air.

b. Inspect. Examine all surfaces carefully for cracks. Replace cracked support. Check straightness of support. Replace support if badly bent. If slightly bent, straighten in arbor press.

33. CRANKCASE BREather AIR CLEANER.

a. Disassemble. Pry off two clips holding air cleaner body to base. Lift oil cup out of base.

b. Clean. Wash parts in dry-cleaning solvent, and dry with compressed air.

c. Inspect. Inspect all parts for damage, and replace damaged parts.

d. Assemble. Place oil cup into position in base. Place lower end of body into oil cup, and snap clips into place.

34. CRANKCASE BREather METERING VALVE.

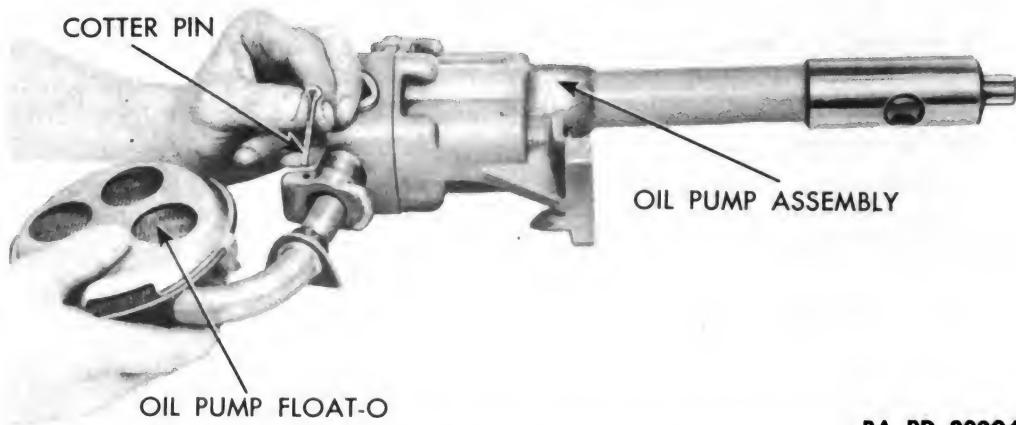
a. Disassemble. Unscrew two halves of body, and remove valve.

b. Clean. Wash all parts in dry-cleaning solvent.

c. Inspect. Examine condition of threads on the two parts of the body. Replace valve if threads are damaged.

d. Assemble. Place valve in lower half of case with stem facing out. Place other half of case marked "UP" over stem end of valve, and screw into place on lower half. Tighten with two wrenches.

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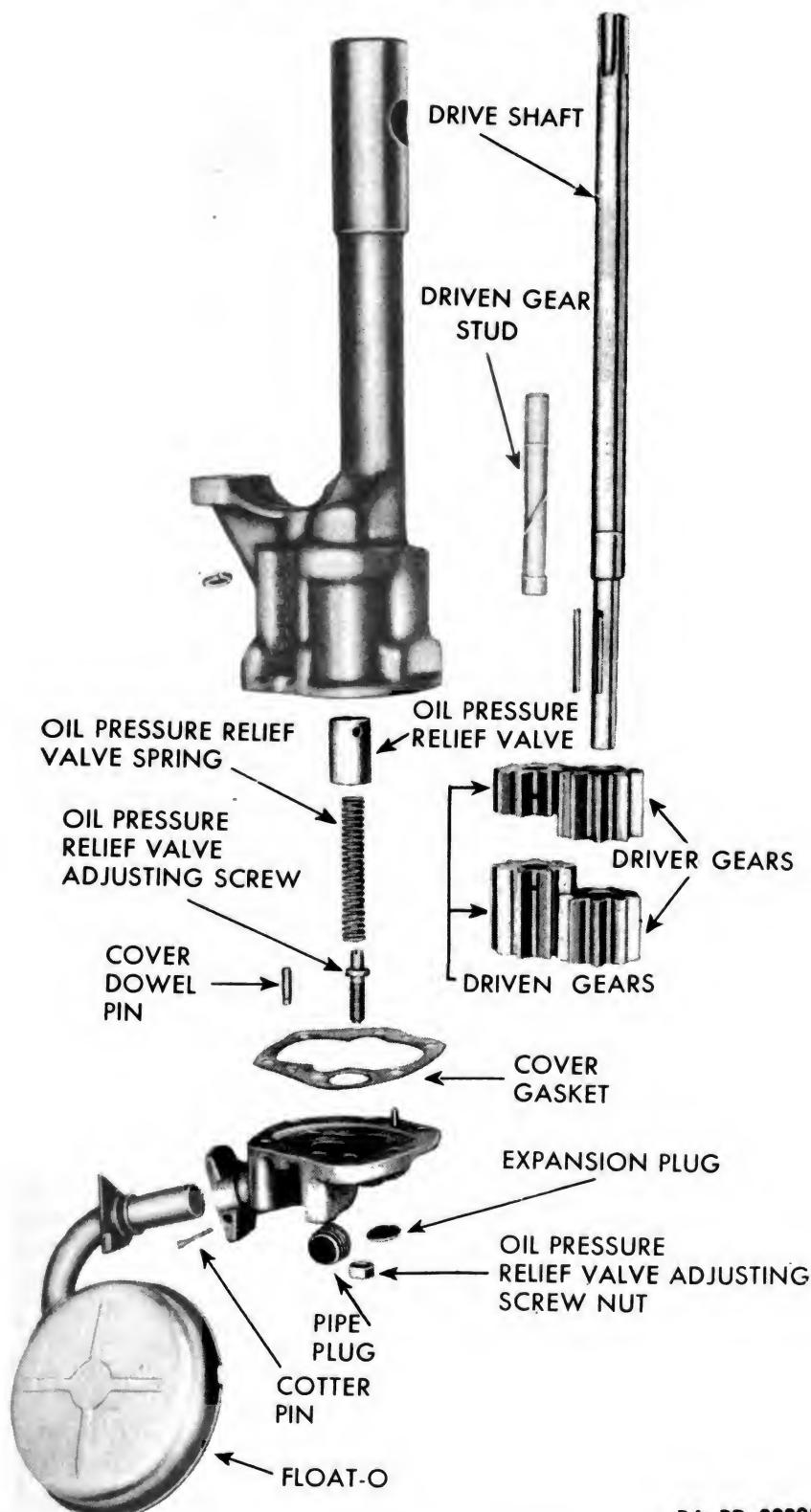
Figure 72 — Removing and Installing Oil Pump Float-O

35. OIL PUMP.

a. Disassemble. Remove cotter pin holding oil pump Float-O to oil pump cover (fig. 72). With screwdriver, pry guard from oil Float-O (fig. 74). Remove six cap screws and lock washers holding cover to body. Lift off cover (fig. 75). Pull driver shaft and driver gears out of pump body (fig. 73). With a puller, remove driver gears from shaft. Tap pump body on piece of wood to remove driven gears, and oil pressure relief valve and spring (fig. 73). With a suitable size drift, drive out driven gear stud (fig. 73).

b. Clean. Wash all parts with dry-cleaning solvent.

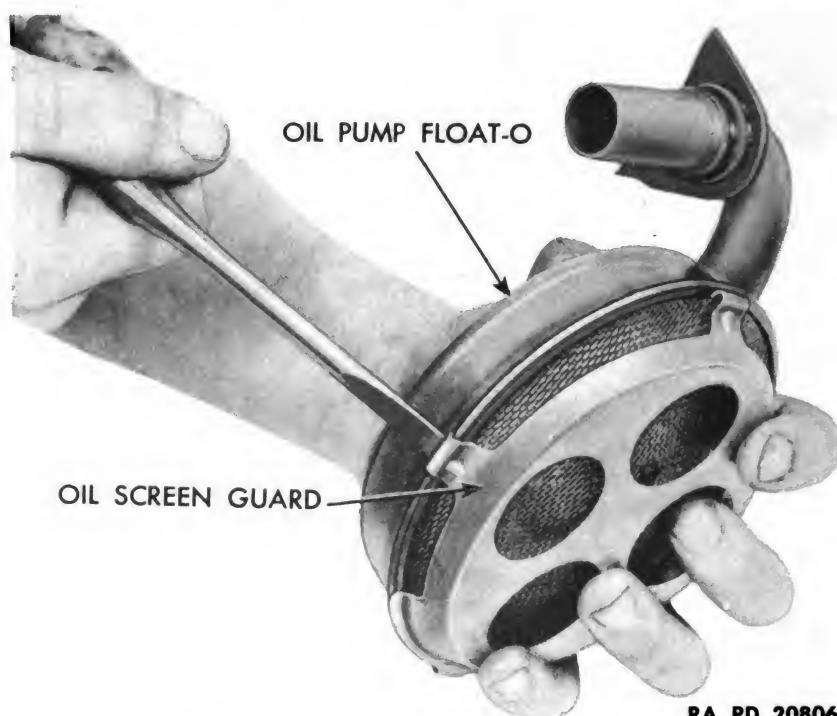
c. Inspect. Examine all surfaces of pump body and cover for cracks. Replace cracked parts. With a plug gage, check driver gear shaft hole in body. The hole in a new body measures 0.625 to 0.626 inch. With a plug gage check the gear bores in pump body. Bores in a new body are 1.713 to 1.714 inches. Measure drive gear shaft hole in cover with plug gage. Hole in new cover measures 0.500 to 0.501 inch. Measure drive shaft with a micrometer at points of wear. A new shaft measures 0.6235 to 0.6245 inch at the large diameter, and 0.4985 to 0.4990 inch at the small diameter. Examine driver gear key on lower end of shaft. If worn or damaged, replace key. Measure driver gear stud with a micrometer. A new shaft measures 0.5015 to 0.5020 inch. With a plug gage, measure inside diameter of both driven gears. Holes in new gears measure 0.5035 to 0.5045 inch. Examine teeth on all gears for wear and nicks. Replace worn or nicked gears. Examine face of oil pump cover. If worn or grooved by the gears, replace cover. Examine screen, and replace if damaged. Measure free length of oil pressure relief spring. Free length of new spring measures $2\frac{15}{16}$ inches, and spring must carry a load of 31 pounds when compressed to $2\frac{1}{4}$ inches. If spring has taken a set, replace. Inspect oil pressure relief valve adjusting screw (fig. 73). If damaged, measure height that screw extends above contact face of cover, and assemble new.

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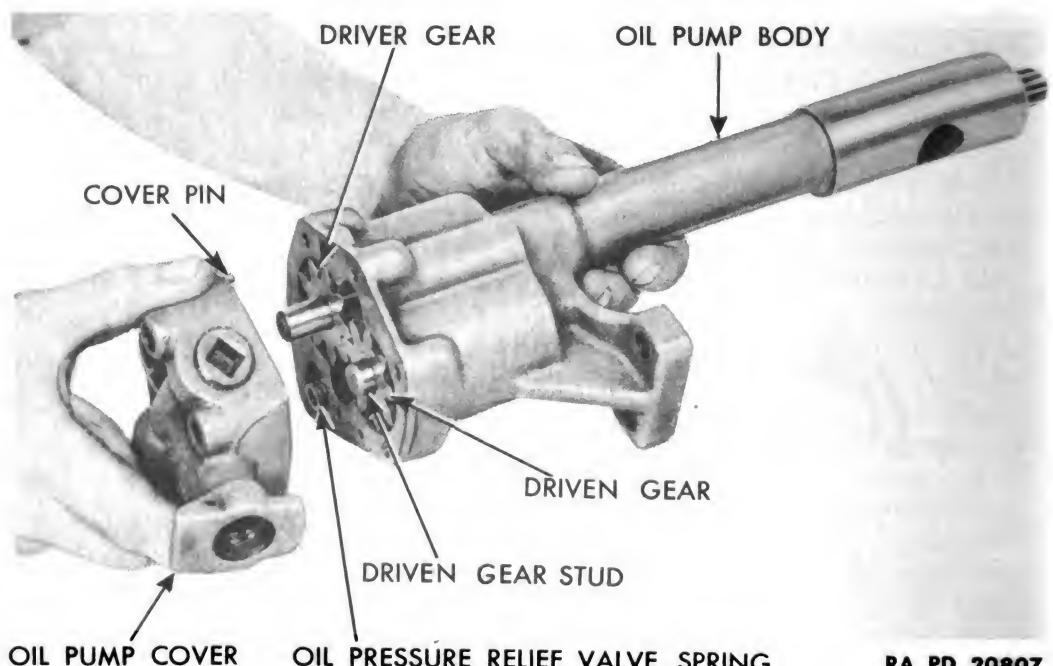
Figure 73 — Oil Pump Components

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RA PD 20806

Figure 74 — Removing Oil Screen Guard



RA PD 20807

Figure 75 — Removing Oil Pump Cover

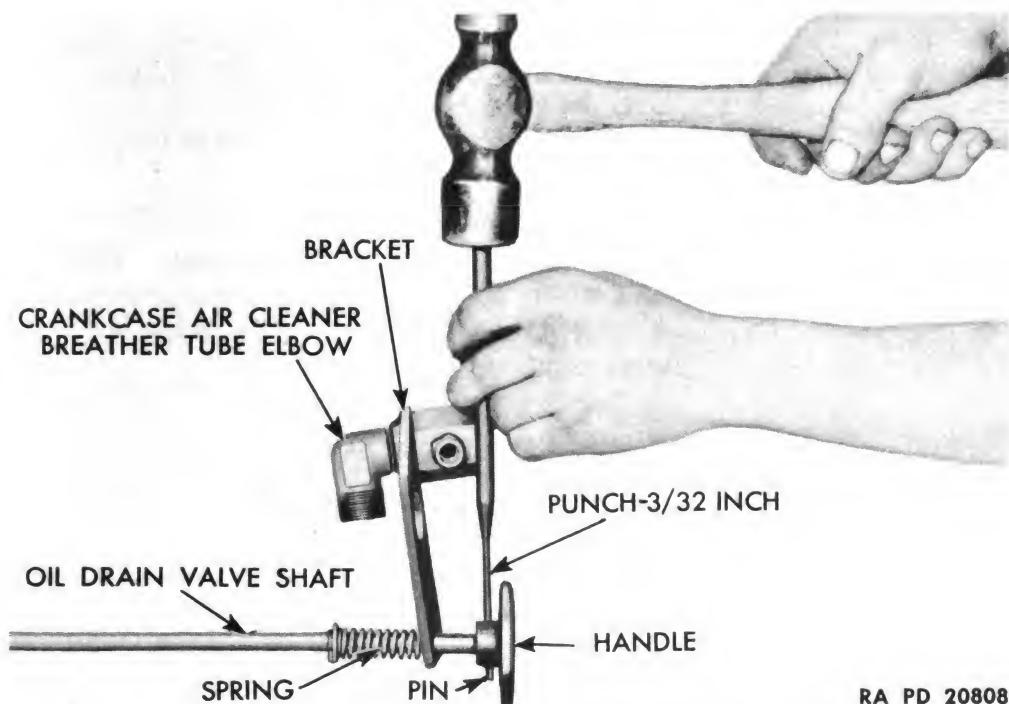
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Figure 76 — Removing Oil Drain Valve Shaft Handle

screw to same height. This will give approximately the same oil pressure when engine is started for test.

d. Assemble. Support pump body on wood blocks in an upright position with top end down. Coat approximately 1 inch of end of driven gear stud, farthest from spiral oil groove, with red lead. Drive coated end into pump body with a lead hammer until top end is flush with outside of pump body (fig. 73). Assemble two drive gears to drive shaft, and drop shaft into place in pump body. Drop oil relief valve and spring into oil relief valve hole in pump body (fig. 73). Drop two oil pump driven gears over driven gear stud and into pump body. Using a new lead gasket, place cover in position on pump body (fig. 73). Fasten cover in place with six lock washers and six cap screws. NOTE: Use two short and four long screws. Tighten screws evenly. Snap guard in place on the Float-O. Insert tube of oil pump Float-O into pump cover, and fasten with cotter pin (fig. 72).

36. OIL DRAIN VALVE SHAFT AND BRACKET.

a. Clean and Inspect. Wash oil drain valve shaft and bracket assembly with dry-cleaning solvent, and blow off with compressed air. Examine spring on shaft. If broken, replace (subparagraph b below). Examine threads on crankcase breather air cleaner elbow. Replace elbow if threads are damaged. Check straightness of rod, and straighten if bent.

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b. Repair. Drive out pin holding handle to shaft (fig. 76), and pull off handle. Remove bracket and spring from rod. Replace spring and bracket on rod. Drive handle onto shaft, making sure pin holes in shaft and handle line up. Drive in a $\frac{1}{8}$ x $\frac{7}{8}$ -inch straight pin to secure handle to shaft. Rivet both ends of pin.

37. CLUTCH PILOT BEARING.

a. Clean. Wash bearing with dry-cleaning solvent. Holding bearing so that it will not spin, blow clean with compressed air.

b. Inspect. Examine bearing for wear. Replace if worn. Pack bearing with No. 2 general purpose grease.

CHAPTER 2 (Cont'd)

ENGINE MODEL R6572 (Cont'd)

Section IV

ASSEMBLY

	Paragraph
Preliminary instructions.....	38
Assembly.....	39

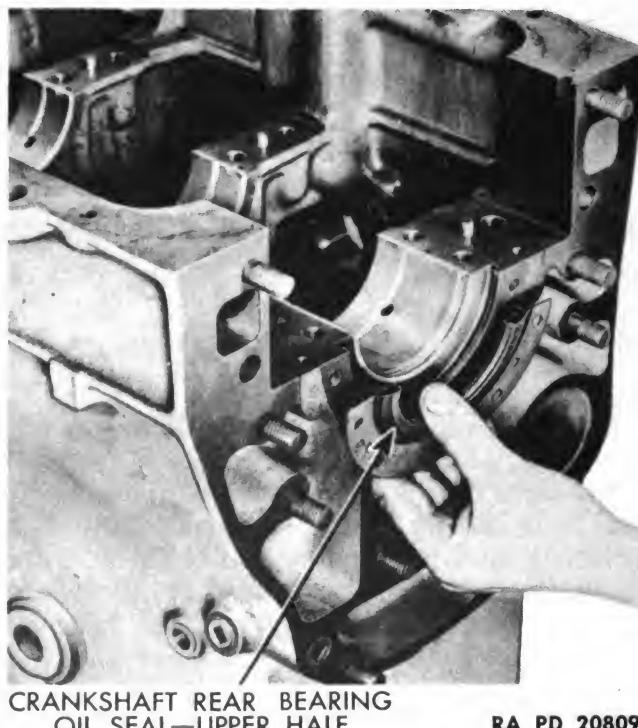
38. PRELIMINARY INSTRUCTIONS.

- a. Always use new gaskets.
- b. Be sure parts are clean before assembly.
- c. Use lock washers on screws, or bolts where specified.
- d. Tighten all nuts and screws firmly.
- e. Refer to TM 9-786 for installation of carburetors, fuel pump, generator, cranking motor, ignition coil, air compressor, coolant pump, scavenger oil pump, carburetor shut-off solenoid and relay, oil cooler, oil filters, distributors, spark plugs, fan, belts, crankcase breather air cleaner, oil level gage rod, and coolant inlet and outlet headers.

39. ASSEMBLY.

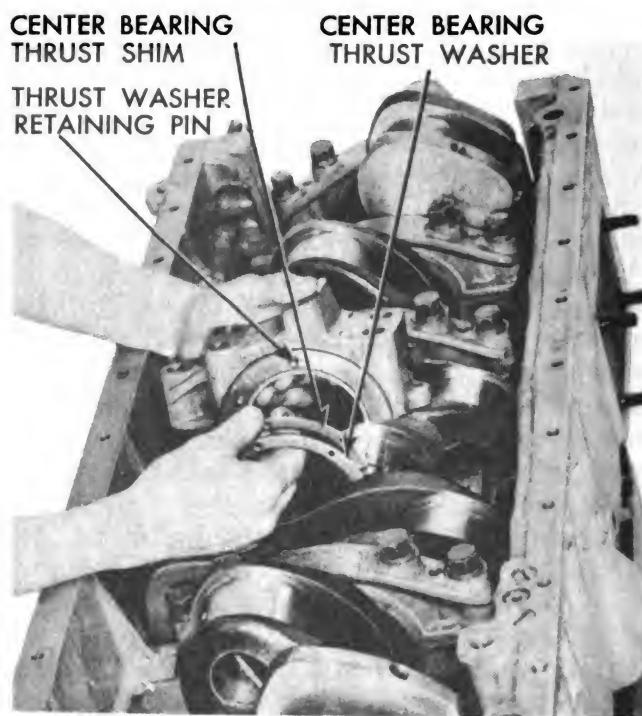
- a. **Install Crankshaft.** Place crankcase upside down in engine stand. Assemble upper half of a new crankshaft rear bearing oil seal at rear bearing (fig. 77), coating crankcase contact side of seal with joint and thread compound. Fasten seal firmly in place with five screws and copper washers. Coat crankshaft contact edge of seal with graphite grease. Install upper halves of crankshaft bearings in crankcase, with tang of bearing fitted into slot at bearing parting line (fig. 40). *NOTE: Upper bearing halves are drilled for oil, whereas lower halves are not.* Lubricate bearings with engine oil. Install front bearing bronze thrust washer, lubricated with graphite grease, on front journal of crankshaft. Carefully lower crankshaft into place on upper bearings with flange end to the rear of crankcase (fig. 39). Install lower bearing halves in bearing caps, and lubricate with engine oil. Assemble all but the center bearing cap in place. Bearing caps are numbered from 1 to 7, starting at front end of crankcase, and should be assembled in proper order. Bearing caps cannot be replaced. Install bearing cap screws with plain washers, and tighten with torque wrench to 100 to 110 foot-pounds. Install thrust washer with shims on center bearing cap retaining pins (fig. 78). Use same number of shims that were removed at disassembly. After tightening center bearing cap screws, force crankshaft forward, so that front thrust flange is tight against front bearing thrust washer. Using a thickness gage (41-G-400), measure clearance at center bearing thrust washer (fig. 79). Clearance should be 0.002 inch. If clearance is more than 0.002 inch, add shims behind thrust plate. If clearance is less than 0.002 inch,

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RA PD 20809

Figure 77 — Replacing Crankshaft Rear Bearing Upper Oil Seal



RA PD 20810

Figure 78 — Installing Center Main Bearing and Thrust Washer

ASSEMBLY

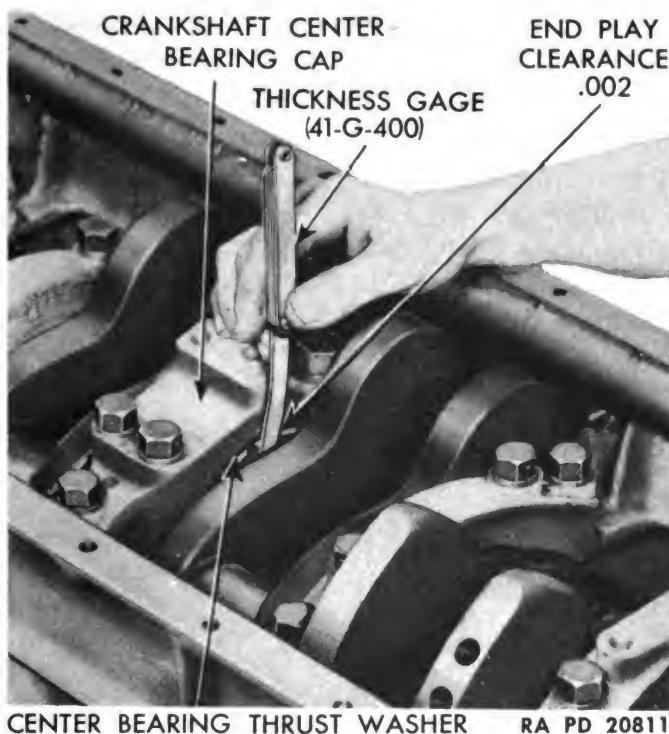


Figure 79 — Measuring Clearance at Center Main Bearing Thrust Washer with Thickness Gage

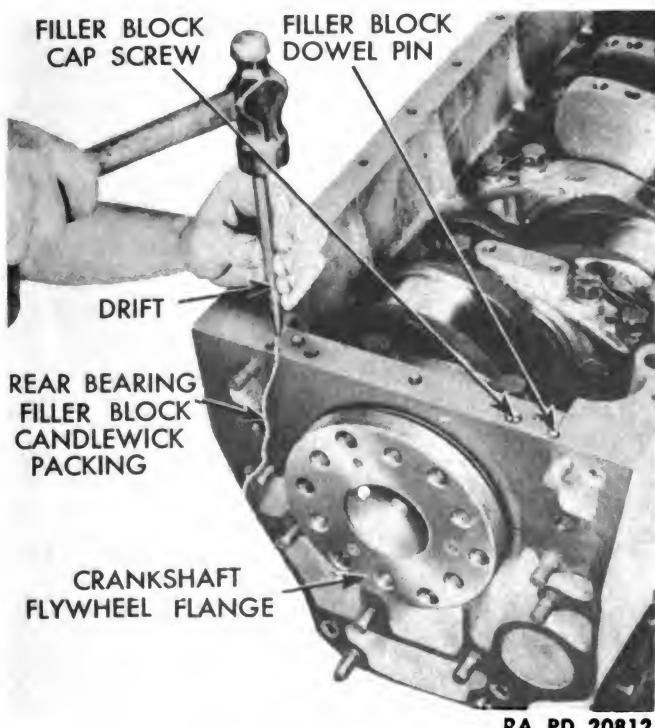
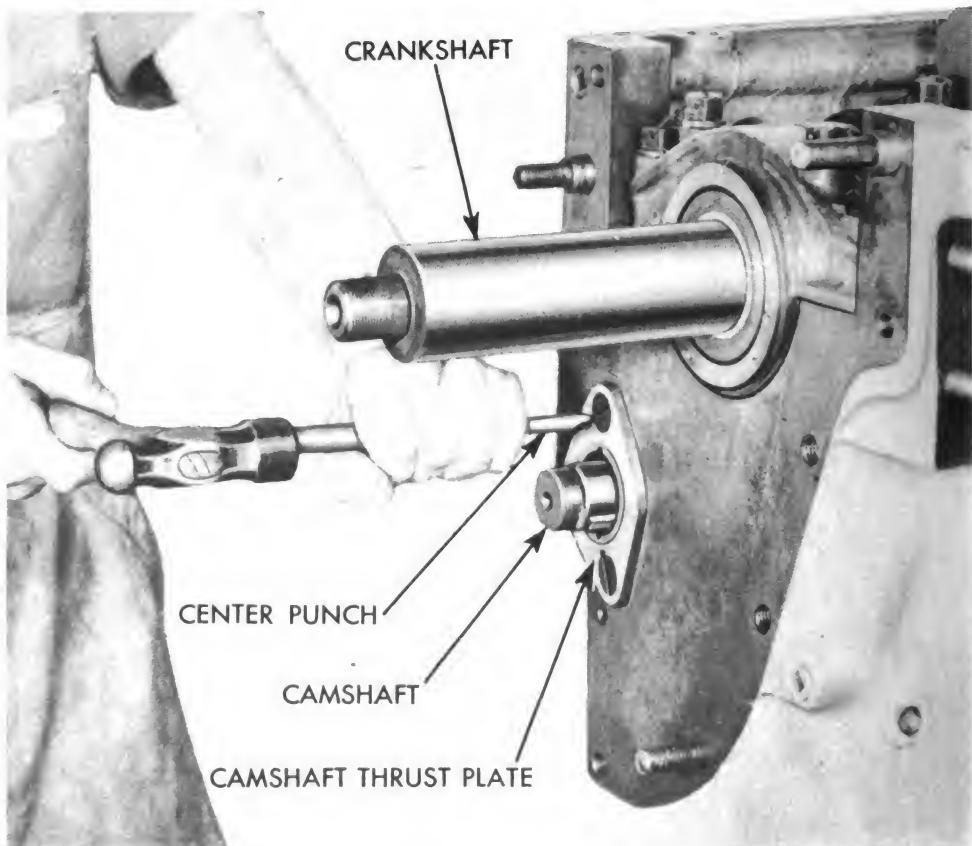


Figure 80 — Packing Rear Bearing Filler Block

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remove shims. After clearance is adjusted, tighten center bearing $\frac{1}{2}$ -inch cap screws to 100 to 110 foot-pounds, and tighten $\frac{9}{16}$ -inch cap screws to 130 to 140 foot-pounds. Secure bearing cap screws with lock wire. Install lower half of a new oil seal in place on rear bearing filler block, first coating surfaces that contact filler block with thread and joint compound. Fasten seal firmly in place with five screws and copper washers. Shellac new gaskets on top edge of filler block. Coat crankshaft contact edge of seal with graphite grease, and install filler block in place (fig. 36), securing it with two flat fillister-head screws and lock washers. Drive in two dowel pins at parting line of crankcase and filler block (fig. 80). Using a suitable size drift, pack grooves on two ends of filler block with candle-wick packing (fig. 80).



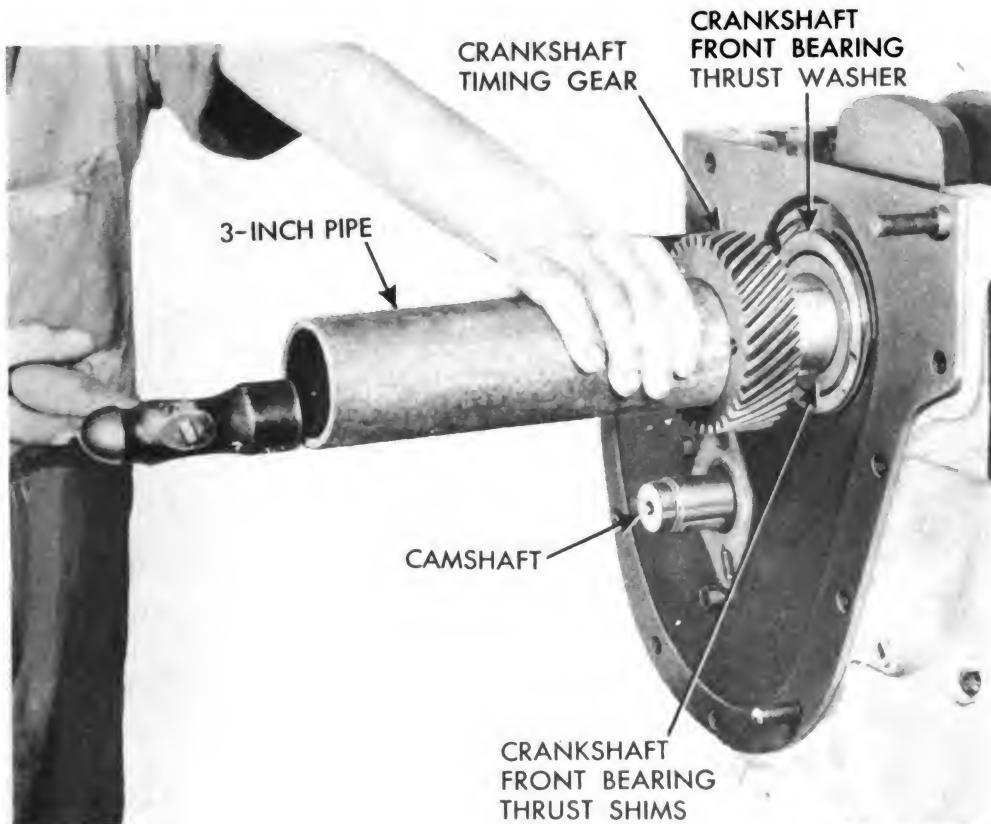
RA PD 20813

Figure 81 — Staking Camshaft Thrust Plate Screws

b. Install Camshaft. Lubricate camshaft journals with engine oil. Slide camshaft into place (fig. 34). Care must be used to avoid nicking bushings in crankcase with camshaft risers. Coat bearing surfaces of camshaft thrust plate with graphite grease, and attach to crankcase with two flat-head machine screws. Stake screws in place with center punch (fig. 81).

ASSEMBLY

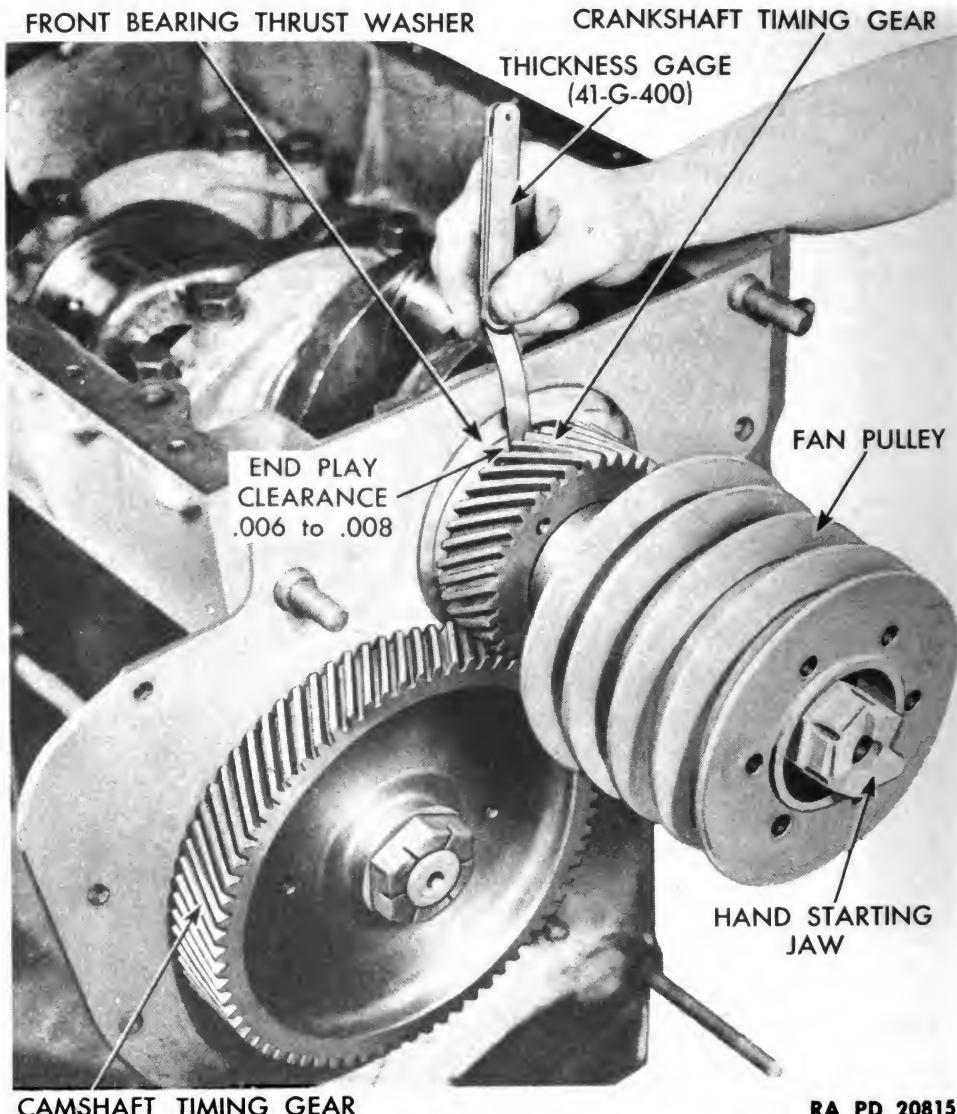
c. **Install Front End Plate.** Shellac a new gasket to front face of cylinder block, and install front end plate (fig. 33). Fasten plate with three cap screws and lock washers. NOTE: *The screw nearest the camshaft has a special thin head.*



RA PD 20814

Figure 82 — Installing Crankshaft Timing Gear with 3-x 8-inch Pipe

d. **Install Timing Gears.** Assemble pack of thrust shims on front end of crankshaft. Coat bearing surface of crankshaft front bearing thrust washer with graphite grease, and install on three retaining pins in crankcase (fig. 82). Install crankshaft timing gear key in crankshaft keyway nearest front bearing. Using a piece of 3-x 8-inch pipe, drive crankshaft timing gear onto shaft, with thrust side towards the thrust washer (fig. 82). Install fan drive pulley and hand starting jaw, and draw up tight. Force crankshaft forward in crankcase, and measure end play of shaft, between timing gear and thrust washer, with a thickness gage (41-G-400) (fig. 83). Correct end play is 0.006 to 0.008 inch. If less than 0.006 inch, add shims. If more than 0.008 inch, remove shims. To change shim pack it is necessary to remove fan drive pulley and timing gear. Remove fan drive pulley and hand starting jaw. Install camshaft timing gear key in slot in front end of camshaft. Hold camshaft forward with a pry bar held against one of the cams inside the crankcase. Do this carefully so that cam is not damaged.

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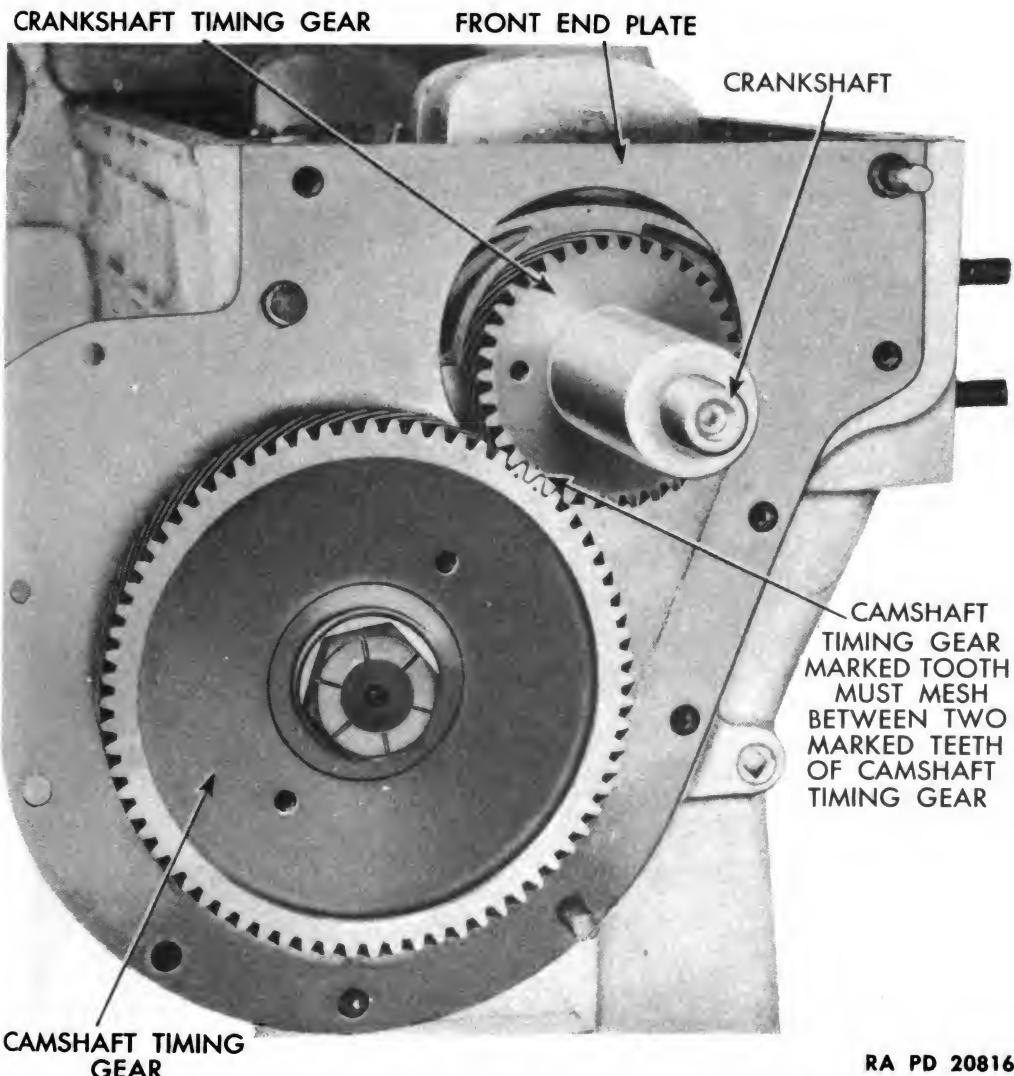
RA PD 20815

Figure 83 — Checking Crankshaft End Play with Thickness Gage

Install camshaft timing gear on camshaft so that center punch-marked tooth of crankshaft timing gear meshes between two marked teeth of camshaft timing gear (fig. 84). Install timing gear attaching nut lock and nut on front end of camshaft, and tighten securely. Lock the nut by bending one edge of nut lock down against the nut. Install crankshaft oil flinger against crankshaft timing gear so that flange points away from engine.

e. **Install Timing Gear Cover.** Shellac a new fan drive pulley dust seal into crankshaft hole of gear cover. NOTE: *The felt seal is installed next to oil seal on side away from crankcase.* Shellac a new gasket to gear cover. Install cover in place, and secure with 7 cap screws, 5 nuts, and 12 lock washers (fig. 29). Install timing

ASSEMBLY



RA PD 20816

Figure 84 — Timing Marks on Camshaft and Crankshaft Timing Gears

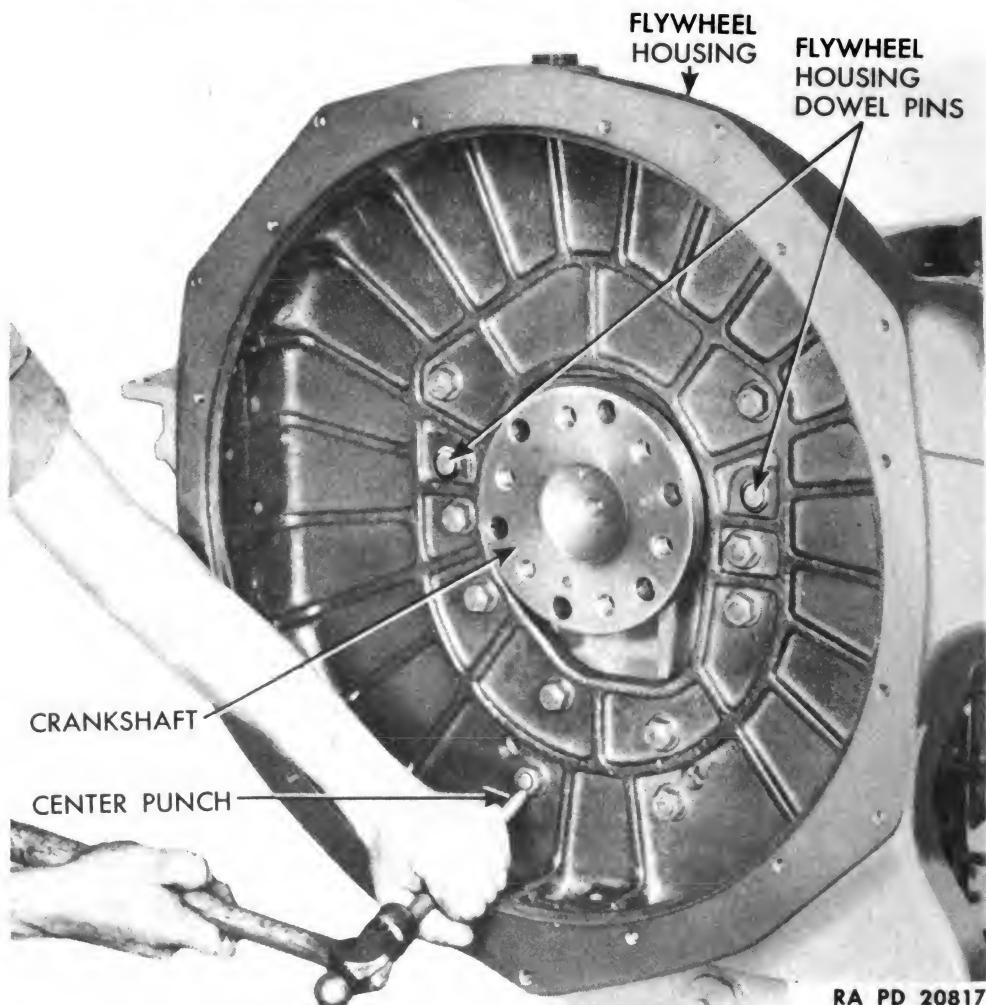
pointer on studs on gear cover, and secure with two nuts and lock washers (fig. 93).

f. **Install Front Engine Support.** Assemble front engine support to trunnion on gear cover. Install long bonding strap to rear side of engine support, and short strap to front side of support, with one cap screw, nut, and lock washer. Attach other end of inner bonding strap to lower left hand screw on gear cover (fig. 8).

g. **Install Fan Drive Pulley.** Install three fan drive pulley keys in keyways in front end of crankshaft. Coat outside of fan drive pulley hub with graphite grease, and drive pulley onto crankshaft with soft hammer, being careful not to strike rim of pulley, as it is easily broken. Install plain washer and hand starting jaw on crankshaft, and tighten hand starting jaw.

h. **Install Damper.** Install vibration damper on fan drive pulley. Assemble two long damper attaching screws to hand

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RA PD 20817

Figure 85 — Staking Flywheel Housing Attaching Stud Nuts

starting jaw lock, with lock washers on the outside of lock, and $\frac{3}{16}$ -inch thick plain washers on the inside. Slide lock onto starting jaw, and tighten the screws to the crankshaft pulley. Assemble and tighten four short screws with lock washers in remaining four holes in damper and fan drive pulley. Secure screws with lock wire.

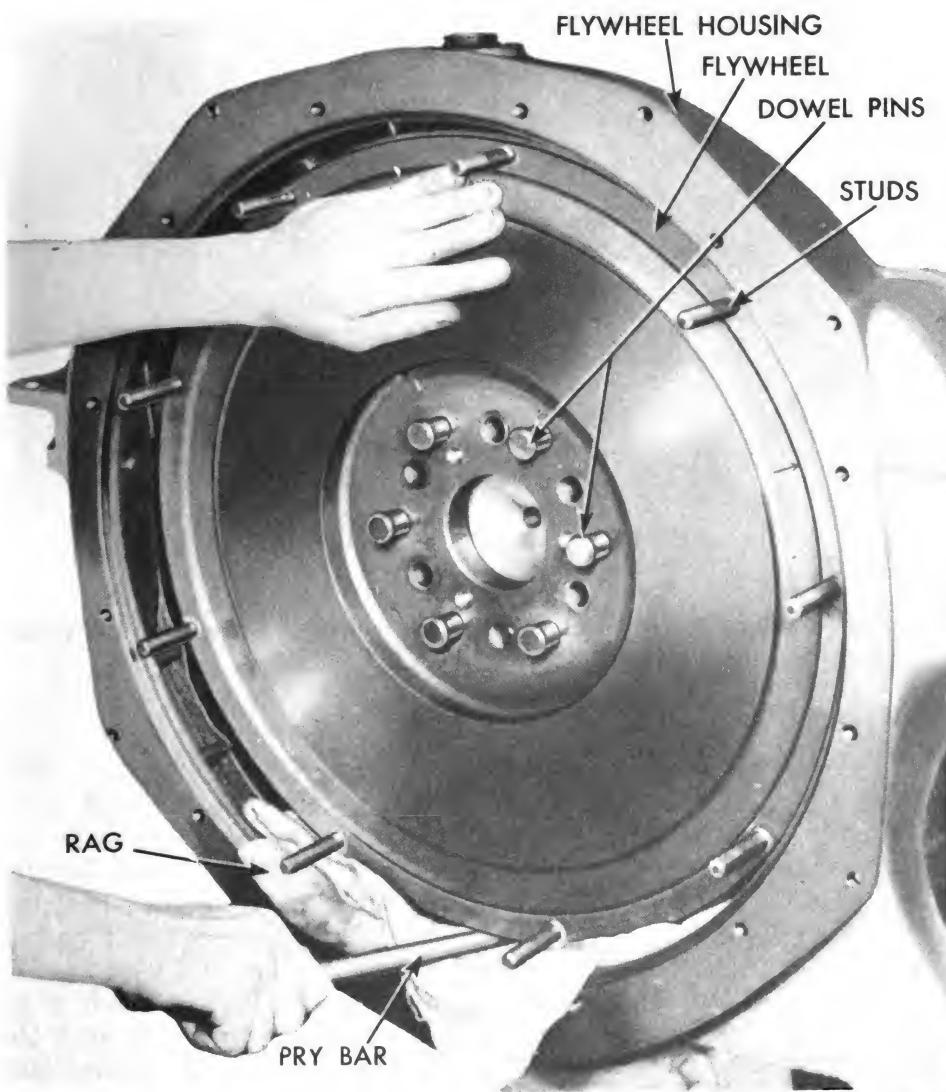
i. Install Flywheel Housing.

(1) **INSTALLING OLD FLYWHEEL HOUSING ON OLD CRANKCASE.** Shellac a new gasket to rear face of crankcase. Mount flywheel housing on studs in rear of crankcase (fig. 28), and drive in two dowel pins (fig. 85). Assemble and tighten 10 nuts with a torque wrench to 100 to 110 foot-pounds.

(2) **INSTALLING NEW FLYWHEEL HOUSING ON OLD CRANKCASE.** Shellac a new gasket to rear face of crankcase. Mount flywheel housing on studs in rear of crankcase. Install 10 nuts on studs, and pull them up snug but not tight. Assemble a nut ($\frac{5}{8}$ -18NF-3) on

ASSEMBLY

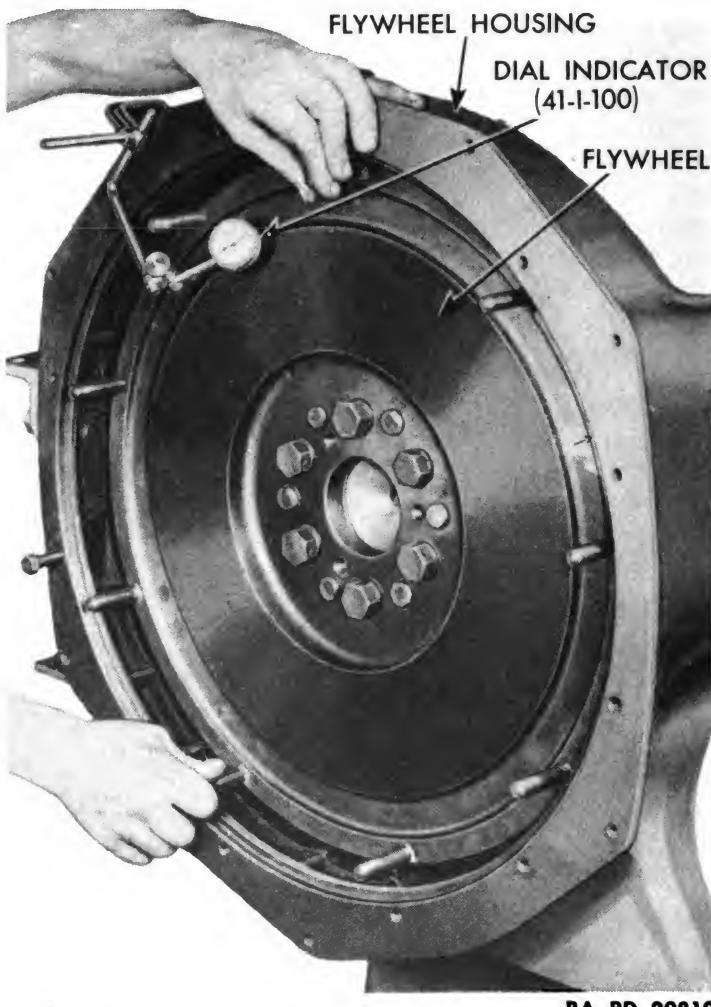
one flywheel attaching cap screw, and install it in tapped hole in crankshaft flange. Tighten nut against flange. Install a dial indicator (41-I-100) on cap screws so that indicator extends to bore of flywheel housing. Turn crankshaft, and check bore of housing. NOTE: *Bore must be concentric within 0.006 inch indicator reading.* Tap side of flywheel housing with a soft hammer at point of high reading, if necessary. After correct reading is obtained, tighten 10 nuts securing housing to crankcase with torque wrench to 100 to 110 foot-pounds. Recheck bore in housing. Stake nuts in place with center punch (fig. 85). Remove cap screw and nut from flywheel flange. With a 0.5725- to 0.5715-inch reamer, ream out two dowel pin holes, and drive in 0.010-inch oversize dowel pins. NOTE: *Oversize dowel pins have "+.010" stamped on the head for identification.*



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Figure 86 — Installing Flywheel

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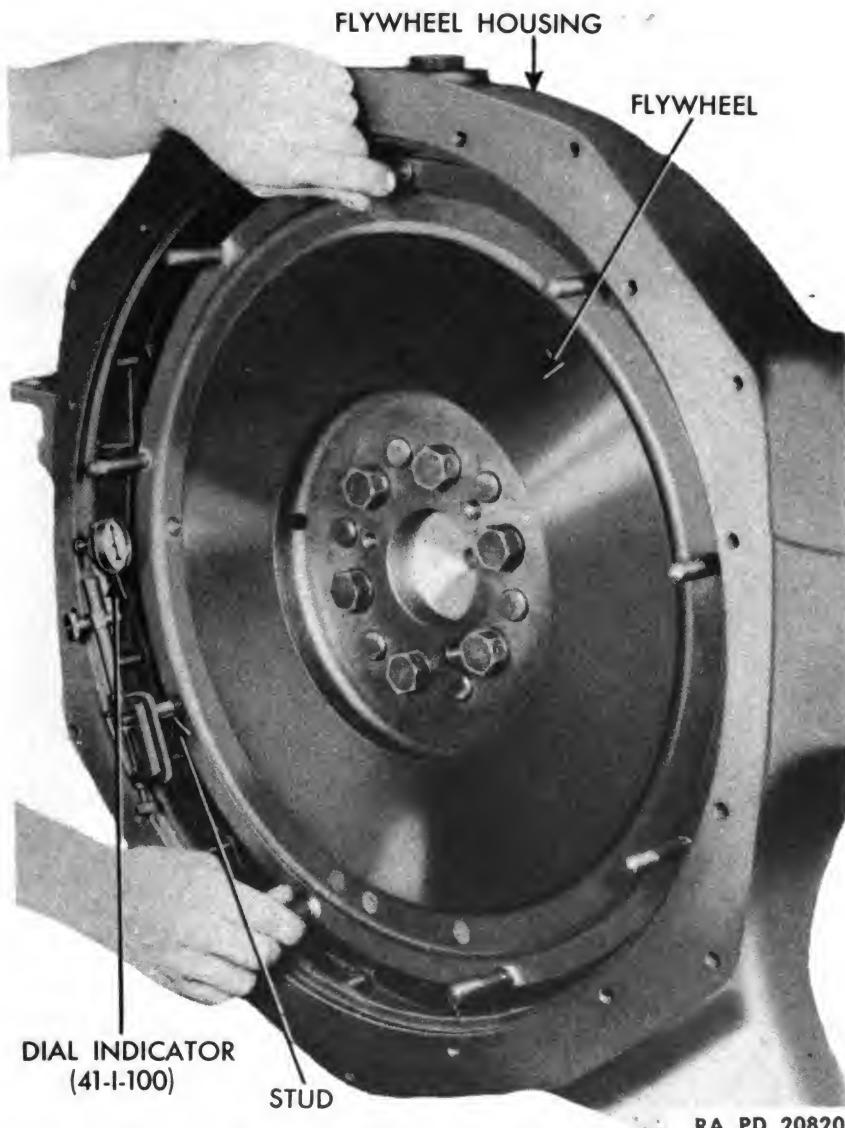
RA PD 20819

Figure 87 — Checking Run-out of Face of Flywheel, Using Dial Indicator

j. Install Flywheel.

(1) **INSTALLING OLD FLYWHEEL ON OLD CRANKSHAFT.** With crankcase upside down, turn crankshaft so that No. 1 and No. 6 crank-throws of crankshaft are facing up. This will bring tapped hole in crankshaft flange, which is offset $\frac{5}{32}$ inch, to the bottom (fig. 26). Lay a rag inside flywheel housing to protect housing bore (fig. 86). Drive six dowel pins flush with the inner face of flywheel. Place flywheel in housing, with screw hole adjacent to letter "O" stamped on flywheel flange at the bottom (fig. 26). With a pry bar, lift flywheel into place (fig. 86). Install six screws and lock washers, and draw up snug but not tight. Drive in six dowel pins. Tighten cap screws with a torque wrench to 145 to 155 foot-pounds. Lock the screws with locking wire. Mount a dial indicator (41-I-100) on flywheel housing to check run-out of flywheel (fig. 87).

ASSEMBLY



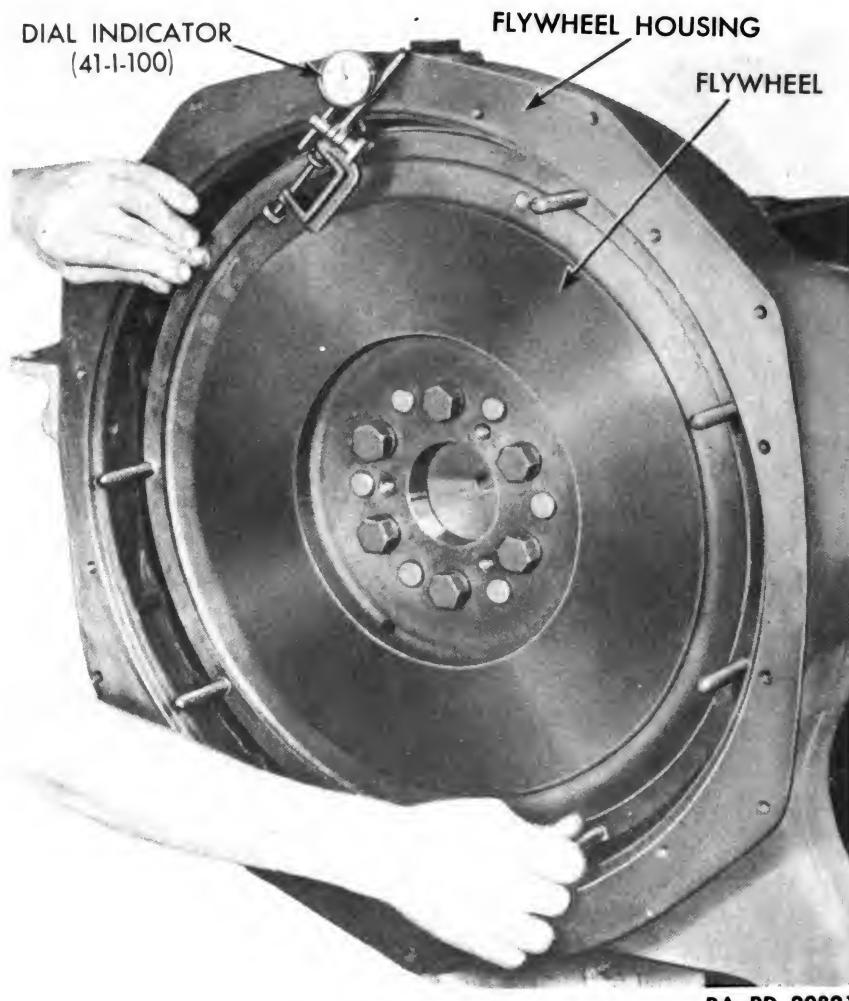
RA PD 20820

Figure 88 — Checking Flywheel Housing Bore, Using Dial Indicator

Turn flywheel one complete revolution very slowly, and note dial readings. The manufacturing run-out is not allowed to exceed 0.006-inch indicator reading. Mount dial indicator (41-I-100) on one of clutch studs on flywheel, and check bore (fig. 88) and face (fig. 89) of flywheel housing. The manufacturing run-out limits for both bore and face of housing are not allowed to exceed 0.006 inch. **NOTE:** *Run-out not to exceed 0.009-inch indicator reading is permissible for clutch fall, and for flywheel housing bore and fall, on old parts.*

(2) INSTALLING FLYWHEEL ON CRANKSHAFT WHEN EITHER OR BOTH PARTS ARE NEW. To install a flywheel on crankshaft, when either or both parts are new, it is necessary to ream out six dowel pin holes. Install flywheel as described in step (1), but do not

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RA PD 20821

Figure 89 — Checking Flywheel Housing Face, Using Dial Indicator

install the dowel pins. With a 0.634- to 0.635-inch reamer, ream out one dowel pin hole in flywheel and crankshaft. Drive in one 0.010-inch oversize dowel pin. Ream out remaining five holes and drive in dowel pins. NOTE: *Oversize dowel pins have "+.010" stamped on the head for identification.*

k. **Install Clutch Pilot Bearing.** Place a small amount of No. 2 general purpose grease in pilot hole of flywheel. NOTE: *An excessive amount of grease is harmful, as it will be forced out and thrown on the clutch plates, causing them to slip.* Start pilot bearing into flywheel bore with shield facing out. Drive in very carefully with a soft drift. Move drive around circumference, so as to drive bearing in evenly. CAUTION: *Be sure to drive against outer race of bearing only.*

ASSEMBLY

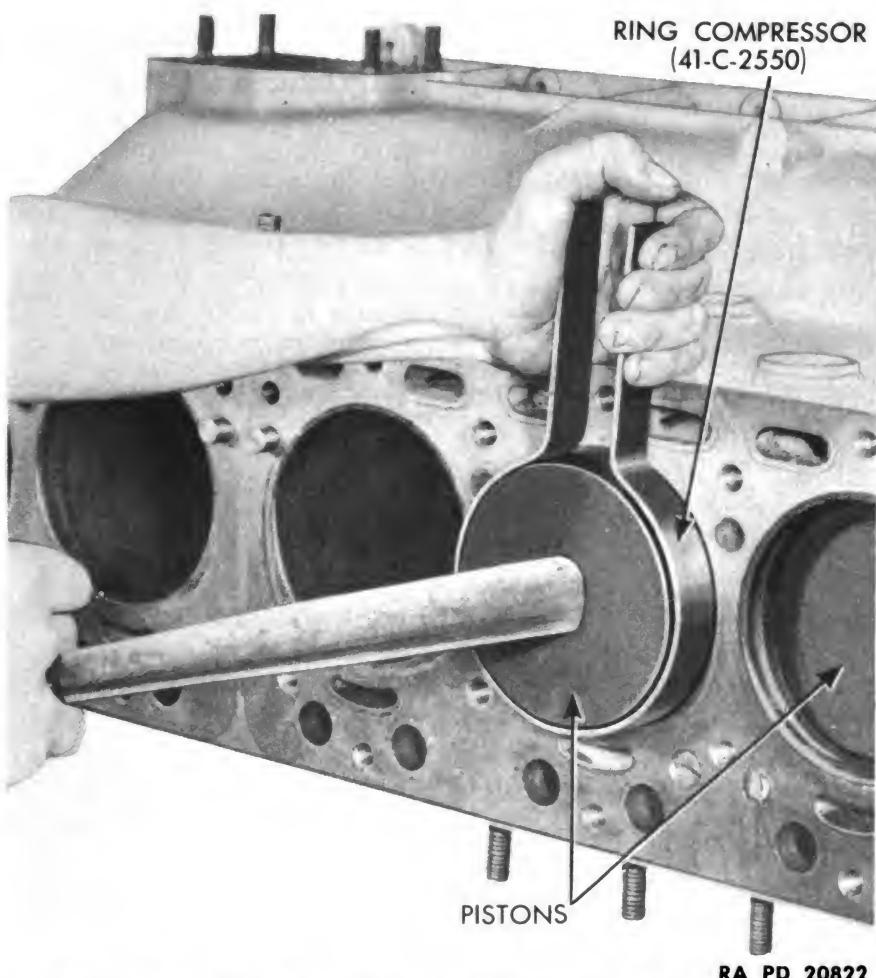


Figure 90 — Installing Piston and Connecting Rod Assembly Using Ring Compressor

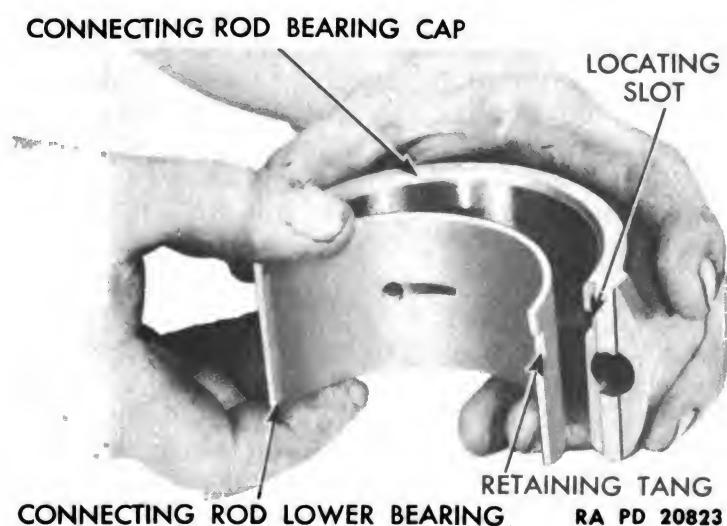


Figure 91 — Installing Bearing in Connecting Rod Cap

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l. Install Connecting Rods and Pistons. Mount engine on stand and rotate to horizontal position (fig. 90). Remove cap from No. 1 connecting rod, and install one-half of connecting rod bearing in rod, with retaining tang inserted in slot at parting line of rod. Space piston ring gaps about 90 degrees apart. Lubricate piston and rings with engine oil. Insert No. 1 connecting rod and piston into No. 1 bore, with numbered side of rod toward camshaft side of engine. *NOTE: Both rod and cap are stamped with cylinder bore number near the parting line. No. 1 bore is at the fan end.* Using a ring compressor (41-C-2550), tap piston into place with hammer handle (fig. 90), being careful not to nick cylinder bore or crankshaft journal with connecting rod. Install lower half of connecting rod bearing in connecting rod cap (fig. 91). Lubricate crankshaft journal, and assemble rod and cap (fig. 23). Tighten connecting rod bolt nuts with torque wrench to 100 to 110 foot-pounds, and lock with cotter pins. Install five other connecting rods and pistons in same manner.

m. Install Scavenger Oil Pump Return Tube. Install scavenger oil pump return tube elbow in crankcase (fig. 27). Attach scavenger oil pump return tube to elbow, and fasten tube clip to crankcase with one nut and lock washer (fig. 21).

n. Install Oil Pump. Insert oil pump pilot into oil pump shaft bore of crankcase, and mount attaching flange of pump on crankshaft center bearing cap with two cap screws and lock washers (fig. 22).

o. Install Oil Pan. Install new Neoprene ring gaskets around the two scavenger oil suction tubes at oil pan flange (fig. 58). Shellac new gasket to oil pan flange. Attach pan to crankcase with 28 cap screws and lock washers (fig. 20). *NOTE: Second screw from flywheel housing on the left side is a special double-end screw, to which is attached the fuel pump primer rod return spring bracket.*

p. Install Valve Tappets and Valve Tappet Covers. Assemble 12 valve tappets into tappet guides, and install them in crankcase (fig. 19). Place six valve tappet hold-down crabs in position on tappet guide shoulders (fig. 18), and fasten down with six screws and lock washers. Shellac new gasket on front tappet chamber cover, and secure in place with six cap screws and lock washers (fig. 17). Repeat operation to install middle tappet chamber cover.

q. Install Cylinder Heads. Place one cylinder head gasket in position on two front cylinder head dowel pins. Lower front cylinder head carefully into place (fig. 16). Install 14 cap screws and plain washers finger-tight. *NOTE: Three 1 3/4-inch long cap screws are used on spark plug side, seven 7-inch long screws on manifold side, and four 6-inch long screws down middle of head.* Tighten screws with a torque wrench, starting at center screw and working toward the ends, to a torque tightness of 100 to 110 foot-pounds. Repeat operations to install rear head.

r. Install Valve Rocker Arms and Rocker Arm Shafts. Insert 12 valve push rods in holes in cylinder heads, seating the ball ends

Original from

ASSEMBLY

into top of tappets (fig. 15). Install 12 valve stem caps over ends of valve stems (fig. 15). NOTE: *The exhaust valve stem caps are deeper than intake valve stem caps.* Place 12 valve actuating ball sockets on top of valve stem caps (fig. 15). Insert valve rocker arm shaft support dowel pin into center hole in bottom of middle rocker arm shaft support, and into drilled hole at middle of rocker arm shaft (fig. 49). This locates shaft so that all oil holes point down. Place rocker arm shaft assembly on cylinder head (fig. 15), making sure that ball ends of rocker arms rest in sockets on top of valve stem caps, and that adjusting screws on opposite ends of rocker arms rest in sockets at top ends of push rods. Secure rocker arm supports to cylinder head with six screws and lock washers. NOTE: *The middle rocker arm shaft support on manifold side uses a plain cap screw $3\frac{1}{8}$ inches long under head. The two end supports use plain cap screws $3\frac{5}{8}$ inches long under the head on the spark plug side. The two special screws with tapped heads and with a length of $3\frac{1}{8}$ inches under the head are used on the two end supports on manifold side. A special screw with tapped head and a length of $3\frac{5}{8}$ inches under the head is used on the middle support on the spark plug side (fig. 49).* Use same operations to install other rocker arm shaft assembly. Refer to TM 9-786 for valve clearance adjustment.

s. **Install Cylinder Head Valve Covers.** Shellac new gasket to cylinder head contact surface of rear cylinder head valve cover, and install in place on rear cylinder head (fig. 14). Secure cover in place with three screws and copper-asbestos washers. NOTE: *The front screw is a hexagonal-head screw, while middle and rear screws are special double-end screws.* Install front cover in same manner, except to use hexagonal-head screws on both ends and a special double-end screw in middle hole.

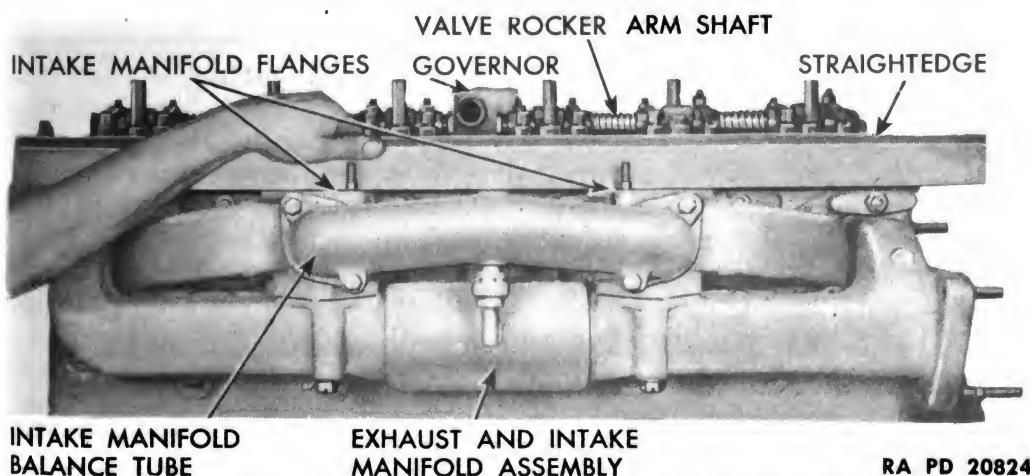


Figure 92 — Lining Up Faces of Intake Manifold Flanges

t. **Install Intake and Exhaust Manifold.** Place two exhaust and intake manifold gaskets on manifold studs in cylinder heads. Install manifold on studs (fig. 13). Assemble four nuts and plain washers on the four end studs, and draw up finger-tight. Assemble

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nine crabs and nuts on the four top intermediate and five bottom intermediate studs, and draw up finger-tight. NOTE: *Bottom middle crab is longer than other eight crabs.* Place straight edge across the two intake manifold flanges (fig. 92). Shift manifolds on studs by tapping with a rawhide mallet until two intake flanges are in line. Tighten 13 manifold to cylinder head stud nuts with a torque wrench to a tightness of 100 to 110 foot-pounds. Assemble two crabs and nuts to the two top end studs, and tighten to 100 to 110 foot-pounds. Tighten the four cap screws holding intake manifold balance tube to intake manifolds. NOTE: *These were assembled snug, but not tight, in paragraph 26 d.* Tighten four cap screws holding exhaust manifolds to intake manifolds, and secure with lock wire. NOTE: *These screws were assembled snug, but not tight, in paragraph 26 d.*

u. Install Intake Manifold Primer Tubes. Use joint and thread compound on all threads. Install two four-way compression tube primer tees (primer spray tubes) in center tapped hole of front and rear intake manifolds, with the middle branch facing away from engine (fig. 68). Install four primer spray tubes in two end tapped holes of front and rear intake manifolds, with side of the hex marked "*" facing away from engine (fig. 68). Install four-way compression tube tee with one blind end in the balance tube. Connect the primer tubes (fig. 68), and draw nuts up tight.

v. Install Water Inlet and Outlet Headers. Shellac four new gaskets to water outlet header and install on studs on top of head. Secure with four nuts and lock washers. Shellac four new gaskets to water inlet header, and secure in place on cylinder head with four screws and lock washers. NOTE: *One screw 3 7/8 inches long, is used at the front end, two screws 3 1/2 inches long are used in the intermediate holes, and one screw 3 inches long is used in the rear hole.*

w. Install Cylinder Head Valve Cover Breather Tube and Intake Manifold Breather Metering Valve. Shellac two new gaskets to cylinder head valve cover breather connection (fig. 12), and install in place. Secure with four nuts and lock washers. Intall intake manifold breather metering valve in intake manifold balance tube. Assemble valve cover breather tube connection in valve cover breather connection, and an elbow fitting in the metering valve (fig. 12). Iustall breather tube connecting metering valve to valve cover breather tube (fig. 12).

x. Install Governor and Governor Drive Housing.

(1) **INSTALL GOVERNOR THROTTLE Box.** Shellac two new gaskets to intake manifold flanges. Install throttle box on intake manifold, with throttle rod extending between cylinder head covers (fig. 12). Secure throttle box in place with six nuts and lock washers.

(2) **INSTALL GOVERNOR DRIVE HOUSING.** Crank engine by hand until No. 6 piston is coming up on compression stroke. This can be determined by placing thumb over No. 6 spark plug hole

ASSEMBLY

TOP DEAD CENTER
TIMING MARK

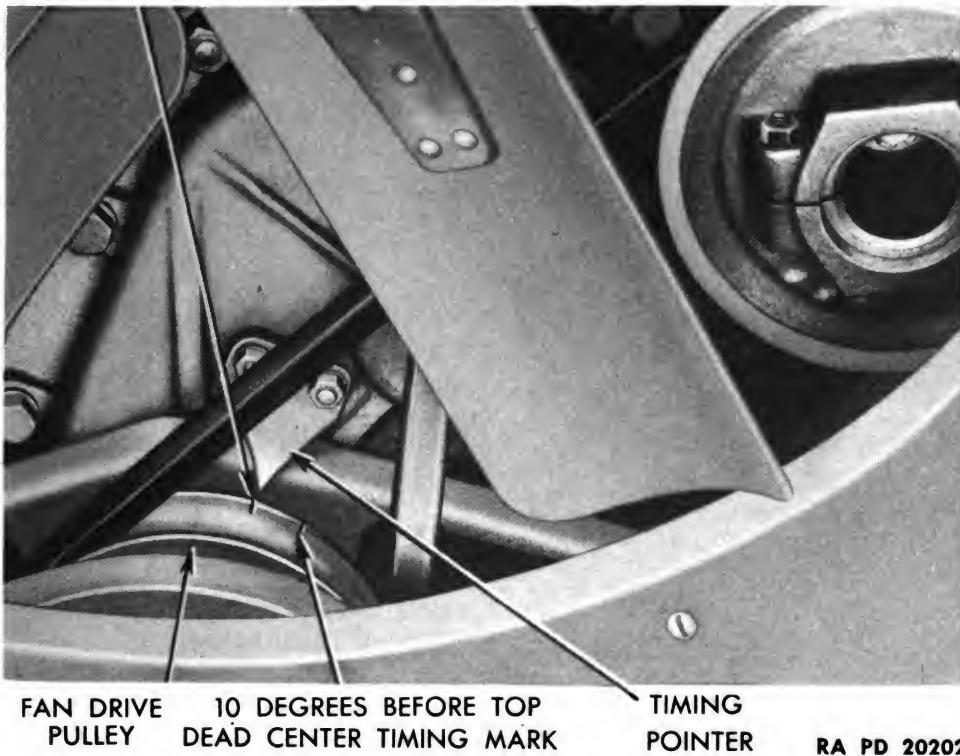
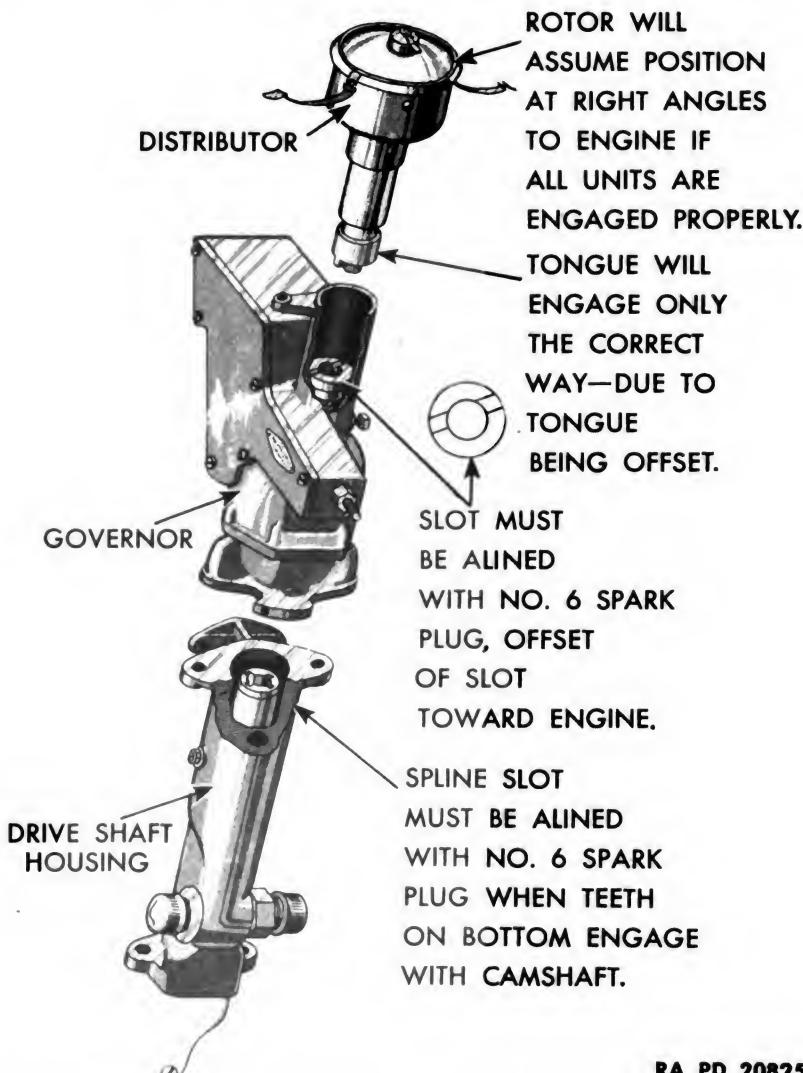


Figure 93 — Top Dead Center Mark on Fan Drive Pulley

until compression in cylinder forces thumb away from hole. Continue to crank until second notch on rim of drive pulley on front of engine is in line with the pointer (fig. 93) (top dead center position). Shellac new gasket to lower end of governor drive housing. When installing, turn governor drive shaft (fig. 11), so that one spline at upper end of shaft is at an angle of approximately 30 degrees with engine center line, or in a line with No. 6 spark plug (fig. 94). Secure governor drive support to crankcase with four screws and lock washers.

(3) INSTALL GOVERNOR. Install governor tube assembly over throttle rod and into throttle box, with spring end out. Remove six screws and lock washers, and remove governor cover (fig. 9). Shellac gasket to lower end of governor. Turn governor shaft so that distributor drive slot at upper end is at an angle of approximately 30 degrees with engine center line, or in line with No. 6 spark plug hole, and with the offset in the slot towards the engine (fig. 94). Install governor, and secure with two nuts and lock washers (fig. 10). Attach angle bracket to two studs, one on water inlet header and one on governor body, and secure with two nuts and lock washers (fig. 9). Assemble oil tube connecting oil cooler housing to governor body (fig. 9). Attach throttle connecting rod to governor throttle lever with screw (fig. 9). With some tension on the governor spring, adjust length of connecting rod by turning

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Figure 94 — Installing Governor and Governor Drive Shaft Housing

rod adjusting link (fig. 9) so that throttle valves will slant approximately 5 degrees from vertical toward the close position. After locking rod adjusting link with check nuts, be sure that rod ends are parallel, and that there is no binding in the linkage. Remove governor spring, and operate lever by hand to check for friction or binding. Linkage must be entirely free and have no play. Install governor spring. Assemble governor throttle lever compartment cover with six screws and lock washers (fig. 9). Refer to paragraph 81 for adjustment of governor.

y. **Install Oil Drain Valve Shaft and Bracket.** Install oil drain valve shaft and bracket on two studs on coolant inlet manifold (fig. 95), and secure with two nuts and lock washers. Attach lower end of shaft to oil drain valve with cotter pin.

ASSEMBLY

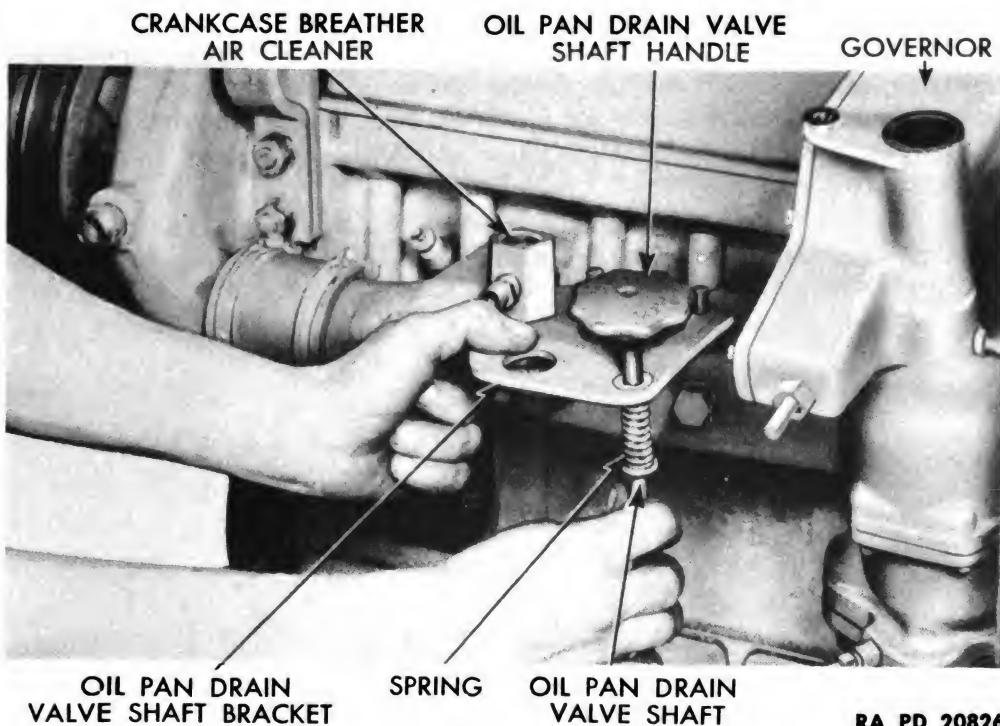


Figure 95 — Removing and Installing Oil Drain Valve Shaft and Bracket



Figure 96 — Crankcase Breather Air Cleaner and Oil Gage Rod

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z. Install Crankcase Breather Air Cleaner. Install crankcase breather air cleaner on oil drain valve shaft bracket (fig. 96). Assemble lower elbow for air cleaner tube in crankcase. Install crankcase breather tube (fig. 96). Install vent tube connecting governor to air cleaner.

aa. Install Oil Gage Rod and Tube. Slide oil gage rod tube through hole in oil pan drain valve shaft bracket, and install lower end in oil drain valve housing. Install oil gage rod in tube (fig. 96).

CHAPTER 2 (Cont'd)**ENGINE MODEL R6572 (Cont'd)****Section V****FITS AND TOLERANCES**

	Paragraph
Fits and tolerances	40

40. FITS AND TOLERANCES.**a. Pistons.****Clearance lands to cylinder wall:**

Top	0.031 to 0.035 in.
No. 2	0.027 to 0.031 in.
No. 3	0.022 to 0.026 in.
No. 4	0.022 to 0.026 in.

Clearance skirt to cylinder bore (gage applied

midway between piston pin bosses)	10 to 15 pound pull on 0.007 x $\frac{1}{2}$ -in. wide feeler gage to slide feeler past piston.
---	--

b. Piston Pins.

Piston pin O.D.	1.4998 to 1.5000 in.
Bushing I.D.	1.5003 to 1.5005 in.
Desired fit in bushing	0.0004 to 0.0005 in.
Pin hole in piston I.D.	1.4998 to 1.5000 in.
Desired fit in piston	Light push fit

c. Piston Rings.

Gap clearance—all rings	0.013 to 0.018 in.
Side clearance (check at several points):	
No. 1	0.005 to 0.007 in.
No. 2	0.002 to 0.004 in.
No. 3	0.002 to 0.004 in.
No. 4	0.0015 to 0.003 in.
No. 5	0.0015 to 0.003 in.

Weight required to compress ring:

Nos. 1, 2, and 3	10 $\frac{1}{2}$ to 14 $\frac{1}{2}$ lb
No. 4	13 $\frac{1}{4}$ lb
No. 5	10 $\frac{1}{2}$ to 16 $\frac{1}{2}$ lb

d. Camshaft.

Journal diameter—all bearings	2.1220 to 2.1225 in.
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Run-out—not to exceed	0.003 in.
Run-out—taken at	all bearings
End play	0.005 to 0.007 in.

e. Camshaft Bearings.

Finished I.D.—all bearings	2.1240 to 2.1245 in.
Clearance	0.0015 to 0.0025 in.

f. Intake Valve.

Stem diameter	0.4969 to 0.4977 in.
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g. Intake Valve Stem Guide.

Outside diameter	0.8755 to 0.8765 in.
Stem hole diameter	0.4975 to 0.4990 in.
Clearance, valve stem guide to valve stem	0.0008 to 0.0021 in.
Clearance, valve stem guide to valve seat	1 $\frac{1}{32}$ in.

h. Exhaust Valve.

Stem diameter	0.494 to 0.495 in.
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i. Exhaust Valve Stem Guide.

Outside diameter	0.8755 to 0.8765 in.
Stem hole diameter	0.4985 to 0.4990 in.
Clearance, valve stem guide to valve stem	0.0035 to 0.0050 in.
Clearance, valve stem guide to valve seat	1 $\frac{5}{8}$ in.

j. Valve Springs.

	<u>Outer</u>	<u>Inner</u>
Free length	2 $\frac{7}{8}$ in.	2 $\frac{7}{8}$ in.
Length, valve closed	2 $\frac{1}{4}$ in.	2 $\frac{1}{4}$ in.
Spring load in pounds at closed length (plus or minus 2 lb.)	70 lb	35 lb

k. Valve Tappets (Intake and Exhaust).

Clearance, engine cold	0.020 in.
Diameter	0.6082 to 0.6087 in.

l. Valve Tappet Guides.

Inside diameter	0.6089 to 0.6101 in.
Clearance, valve tappet to guide	0.0002 to 0.0019 in.

m. Valve Rocker Arm.

Shaft diameter	0.9680 to 0.9687 in.
Bushing inside diameter	0.9687 to 0.9692 in.

FITS AND TOLERANCES

Clearance, bushing to shaft	0.0000 to 0.0012 in.
Desired clearance	0.001 in.

n. Connecting Rod Bearings.**Thickness:**

Side	0.0992 to 0.0995 in.
Bottom	0.0997 to 0.1000 in.

o. Clearance Limits.

Sidewise	0.0022 to 0.0046 in.
Up and down	0.0012 to 0.0036 in.
Desired clearance—up and down	0.0025 to 0.0030 in.
Side play	0.006 to 0.010 in.

p. Crankshaft.

Crankshaft journal size	3.249 to 3.250 in.
End play	0.006 to 0.008 in.
End play adjustment	Shims back of crank-shaft timing gear and at center bearing

q. Crankshaft Bearings.

Thickness	0.1232 to 0.1235 in.
Clearance limits, bearings to crankshaft	0.0022 to 0.0046 in.
Desired clearance, bearings to crankshaft	0.003 in.

r. Cylinders.

Bore size	4.749 to 4.751 in.
Maximum oversize permissible	0.060 in.
Out-of-round limit	0.001 in.
Taper limit within	0.001 in.

s. Flywheel.

Run-out limits:	
Actual	0.003 in.
Indicator	0.006 in.

t. Flywheel Housing.

Bore concentricity limits:	
Actual	0.003 in.
Indicator	0.006 in.

u. Governor Drive Shaft.

Diameter of shaft	0.6225 to 0.6230 in.
I.D. of bushing	0.624 to 0.625 in.

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Clearance, shaft to housing 0.0010 to 0.0025 in.

v. Torque Wrench Tension.**Crankshaft bearing cap screws:**

Center bearing cap screws	130 to 140 ft-lb
All other bearing cap screws	100 to 110 ft-lb
Connecting rod bolt nuts	100 to 110 ft-lb
Cylinder head screws	100 to 110 ft-lb
Manifold stud nuts	100 to 110 ft-lb
Flywheel screws	145 to 155 ft-lb
Flywheel housing stud nuts	100 to 110 ft-lb

NOTE: Above table is for clean, dry threads. If threads are clean and oiled, deduct 10 foot-pounds.

CHAPTER 3

COOLING SYSTEM

Section I

DESCRIPTION AND OPERATION

Paragraph

Description and operation 41

41. DESCRIPTION AND OPERATION.

a. The circulating cooling system has a liquid capacity of 20 gallons. The liquid cools the engine cylinders, cylinder heads, engine lubricating oil, clutch gear reduction unit, and air compressor. Heat is removed from the coolant through two large fin-and-tube type radiators mounted in each side of the sealed engine compartment. Air is drawn into the engine compartment through these radiators and is blown out at the rear of the compartment by a six-blade fan.

b. Coolant is circulated by a pump which is mounted to the front of the engine (rear of vehicle) and driven by three V-belts from a pulley on the crankshaft. The pump forces the coolant through the inlet header, cylinder heads, and engine lubricating oil cooler. It also forces some coolant through the air compressor. From the engine heads the coolant flows out through the outlet header and thermostat housing. There are four thermostats, located in the passages between the outlet header and the thermostat housing, which stay closed until the engine has reached its efficient operating temperature, and then automatically open. While the thermostats are closed, the coolant flows through a by-pass in the thermostat housing direct to the pump to be re-circulated through the engine and engine lubricating oil cooler. The thermostats open when efficient engine operating temperature is reached, and the coolant then circulates through the radiator and clutch gear reduction unit. When the thermostats are open, the by-pass is closed.

c. The cooling system is sealed. The overflow of coolant is controlled by a pressure release valve. No coolant is discharged from the overflow until the engine is hot and the pressure within the system reaches 7 pounds. At this pressure, water will not boil until it reaches 225°F. All coolant discharged through the overflow is stored in an overflow tank. As the cooling system cools, the coolant in the overflow tank is returned to the system.

d. A cooling system filler cap is located on top and at the rear of the vehicle. A filler bowl located directly under the filler cap is connected by hose to each radiator. The vent hose prevents the system from becoming air-bound when filling.

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CHAPTER 3 (Cont'd)

COOLING SYSTEM (Cont'd)

Section II

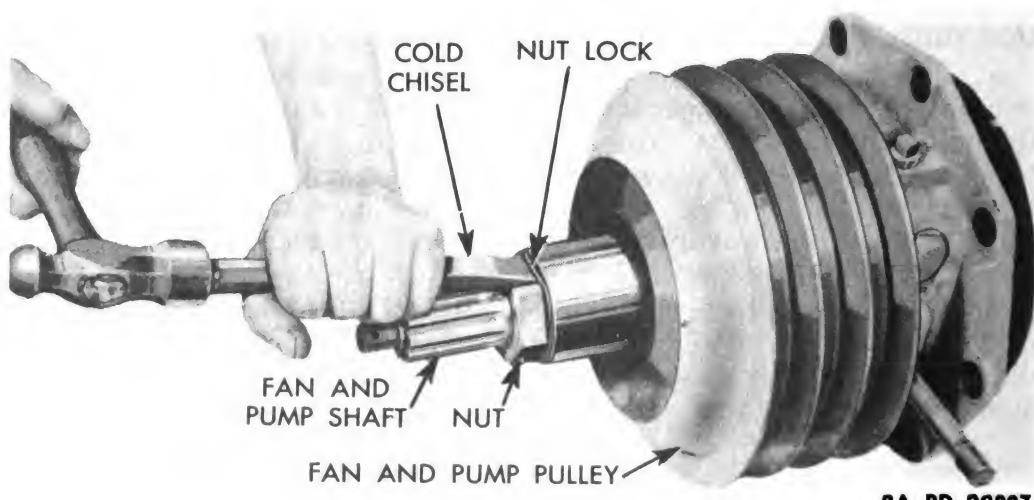
COOLANT PUMP AND FAN CLUTCH

	Paragraph
Description and operation	42
Disassembly	43
Cleaning	44
Inspection	45
Assembly	46

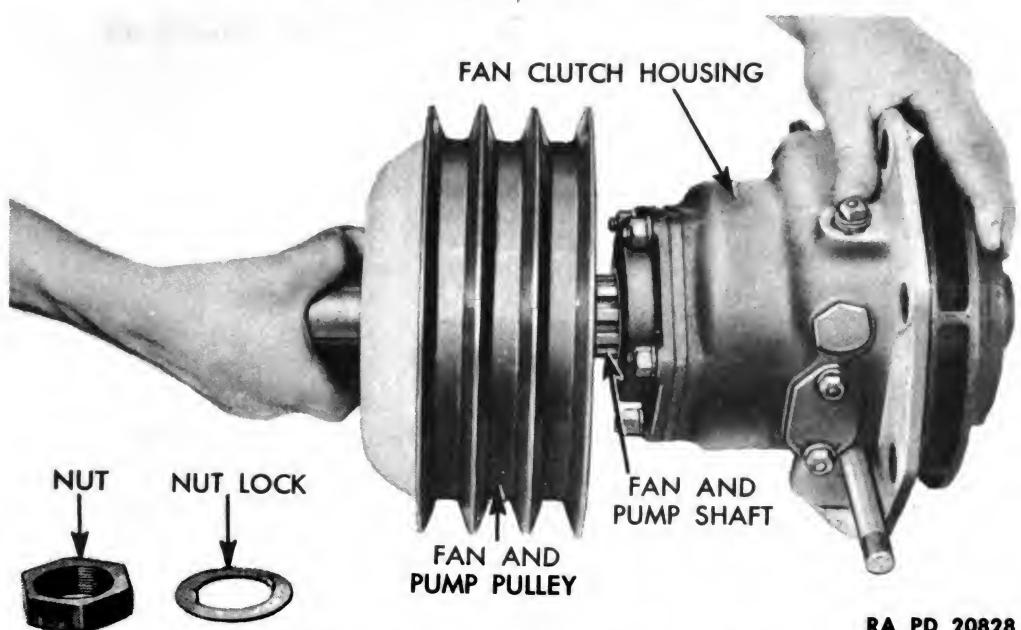
42. DESCRIPTION AND OPERATION.

a. The coolant pump is a centrifugal-type pump attached to the front of the crankcase and cylinder head. It has a capacity of 200 gallons per minute at 2,900 engine revolutions per minute. It is driven by three V-belts from a pulley, carried on two annular ball bearings, on the front end of the fan and pump shaft. The impeller is pinned to the rear end of this shaft. Also mounted on the fan and pump shaft is a clutch which permits the engine fan to be disengaged while fording streams. Coolant is prevented from leaking around the fan and pump shaft by a carbon seal, which is held against a polished seat on the pump housing by a bronze coil spring. A rubber seal is used in conjunction with the carbon seal.

b. Removal and installation procedure is described in TM 9-786.



COOLANT PUMP AND FAN CLUTCH



RA PD 20828

Figure 98 — Removing Fan and Pump Pulley

43. DISASSEMBLY.

a. Remove Fan and Pump Pulley. Straighten the fan and pump pulley nut lock with a cold chisel (fig. 97). Remove nut and nut lock from shaft. Slide pulley off splined shaft (fig. 98).

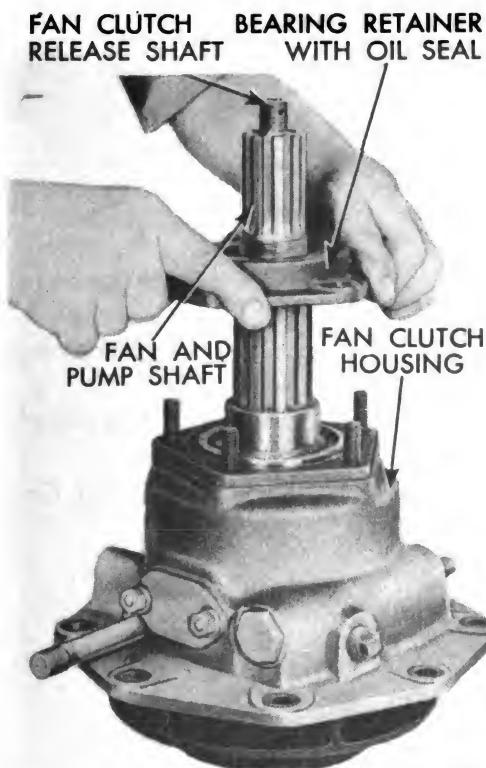
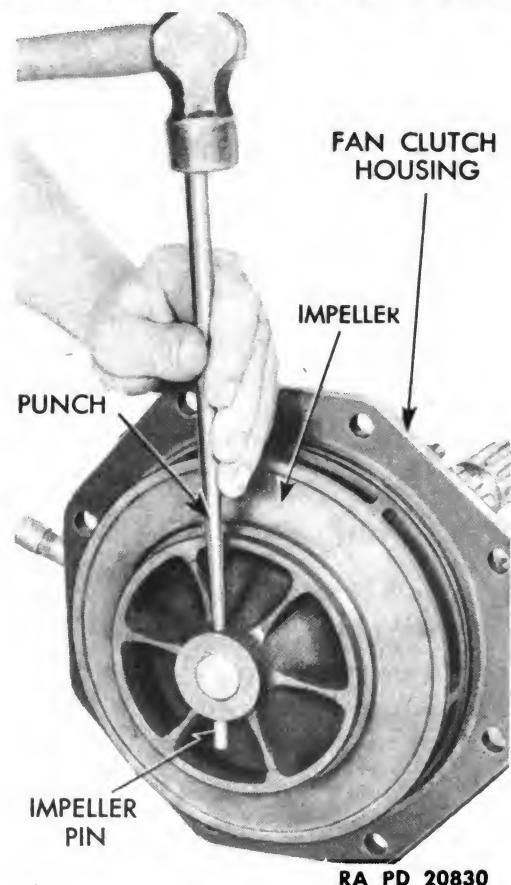
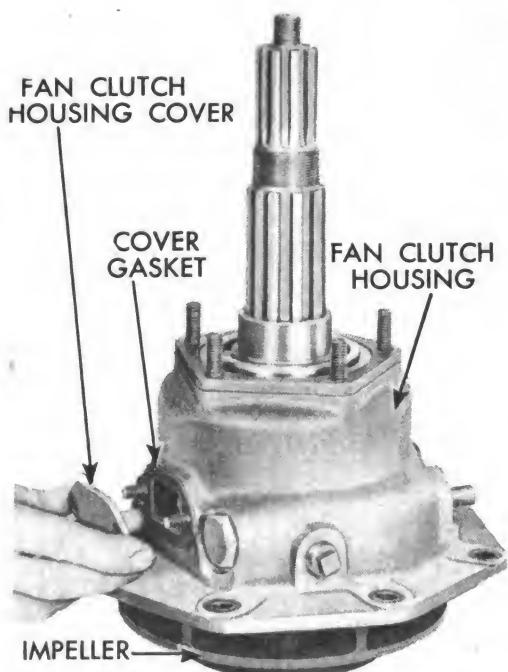


Figure 99 —

Removing
Pump Bearing
Retainer

RA PD 20829

ORDNANCE MAINTENANCE — ENGINE, ENGINE ACCESSORIES, CLUTCH GROUP,
AND PROPELLER SHAFT FOR 13-TON, HIGH-SPEED TRACTOR M5**Figure 100 —****Removing****Impeller Pin****Figure 101 —****Removing****Fan Clutch****Housing Cover**

COOLANT PUMP AND FAN CLUTCH

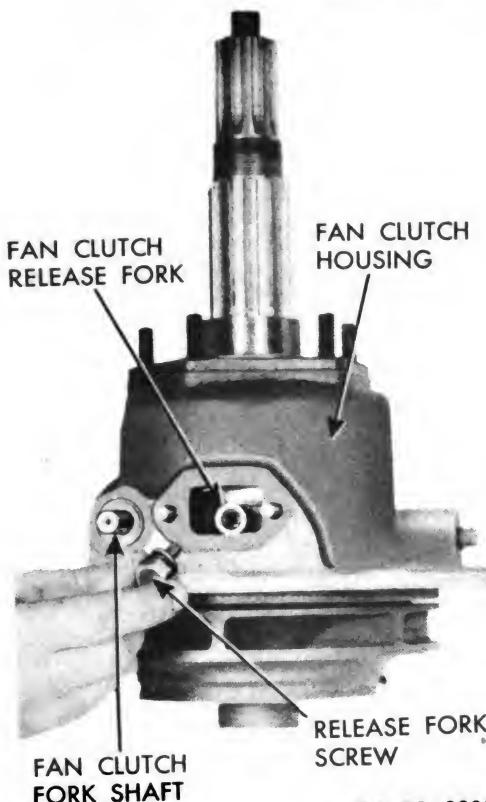


Figure 102 —

Removing

Fan Clutch

Release Fork Screw

RA PD 20832

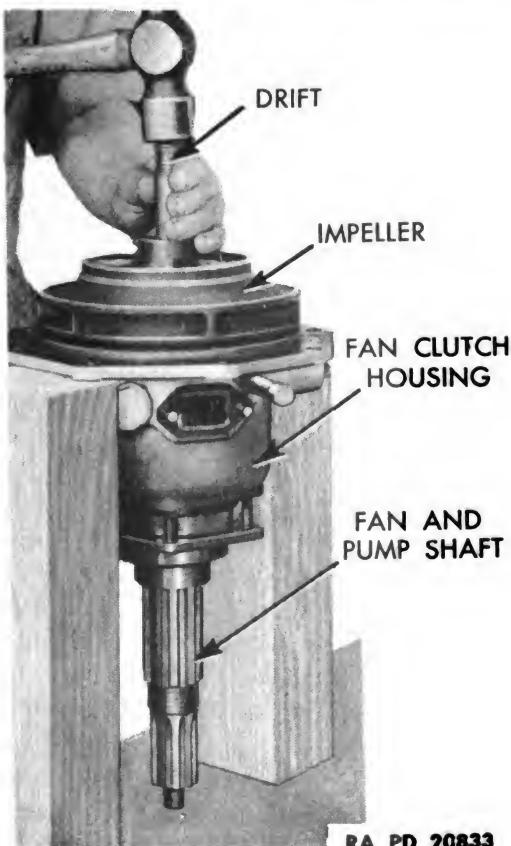


Figure 103 —

Driving Fan

and Pump Shaft

from Impeller

RA PD 20833

103

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AND PROPELLER SHAFT FOR 13-TON, HIGH-SPEED TRACTOR M5**

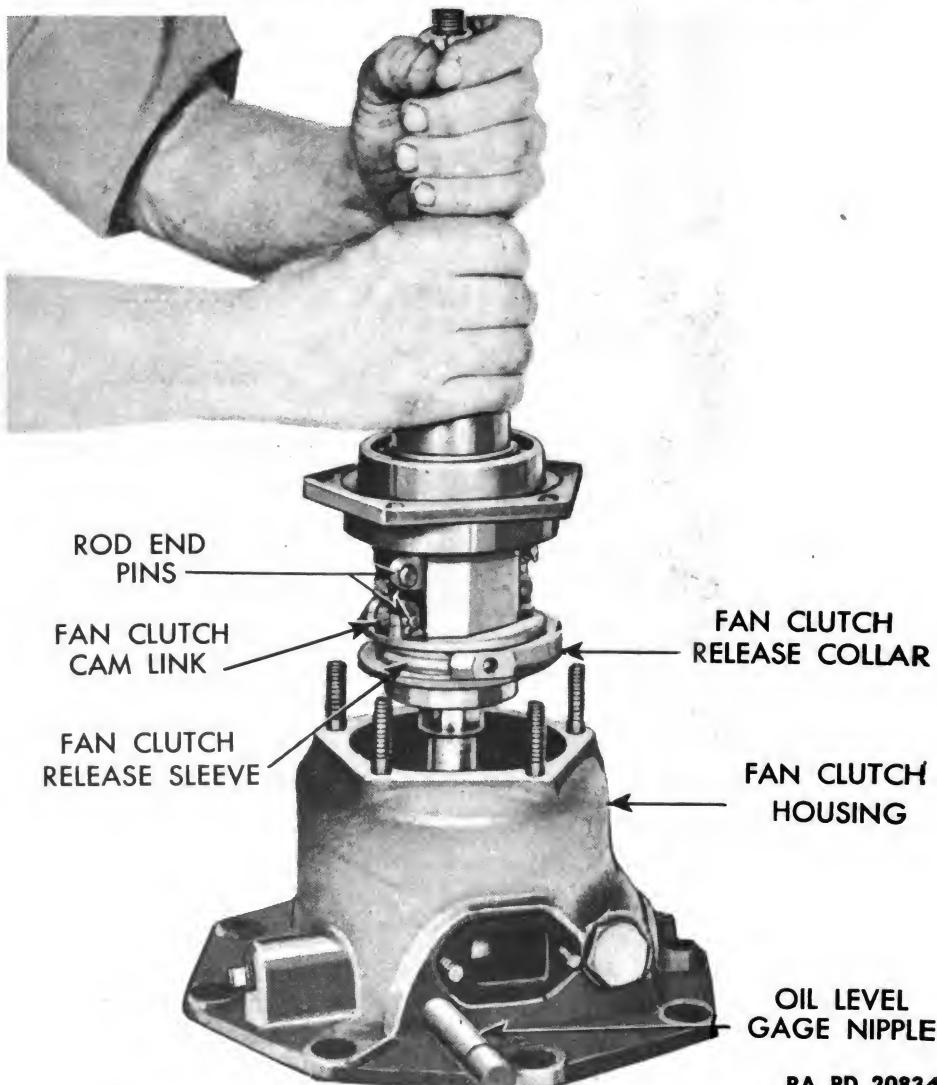
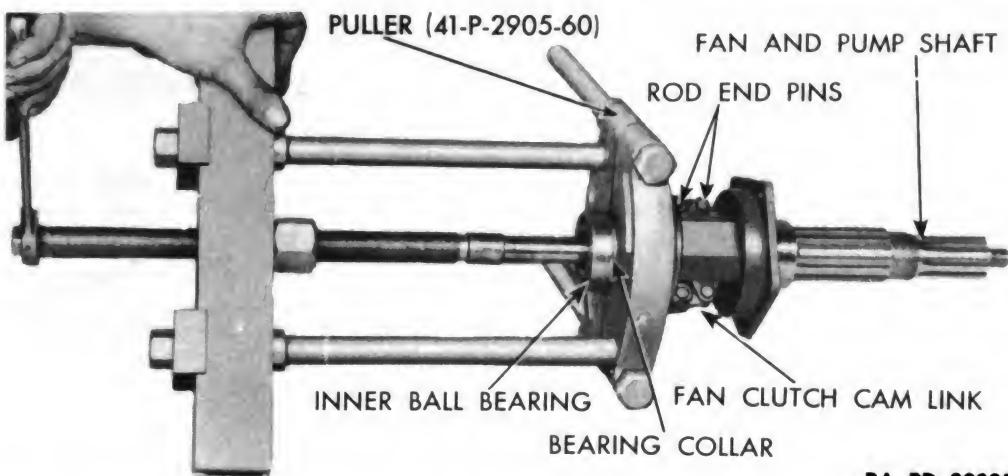


Figure 104 — Removing Fan and Pump Shaft Assembly

b. Remove Fan and Pump Shaft Assembly. Remove five nuts and lock washers attaching pump bearing retainer, and remove retainer with oil seal (fig. 99). Drive out impeller retaining pin with a punch (fig. 100). Remove four nuts and lock washers attaching two fan clutch housing covers, and remove covers and gaskets (fig. 101). Reaching through housing cover openings, remove two fan clutch release fork screws and lock washers (fig. 102). Supporting fan clutch housing on two blocks of wood, drive fan and pump shaft out of impeller with suitable driver (fig. 103). Fan and pump shaft assembly can now be lifted from fan clutch housing (fig. 104).

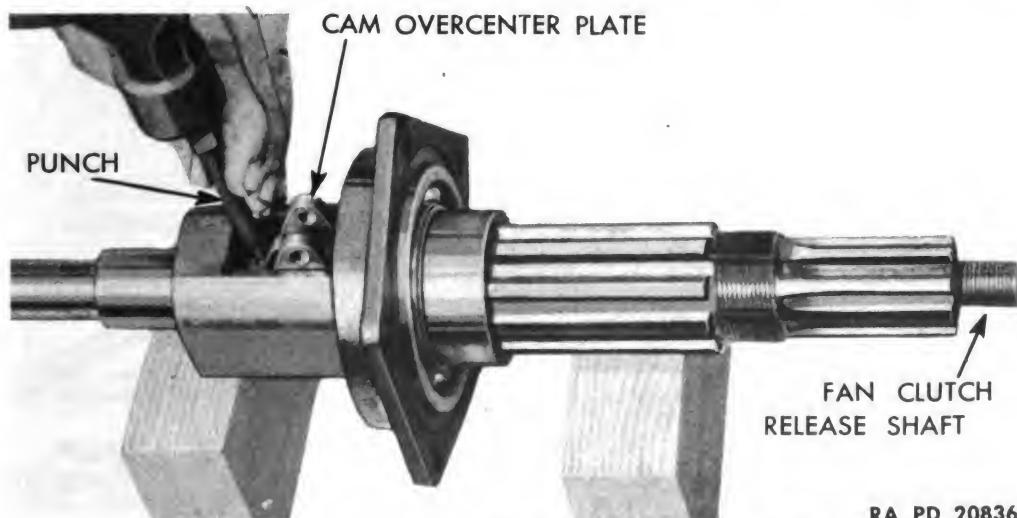
c. Disassemble Fan and Pump Shaft Assembly. Remove fan clutch release collar from release sleeve (fig. 104). Using a puller (41-P-2905-60), remove inner ball bearing and bearing collar from

COOLANT PUMP AND FAN CLUTCH



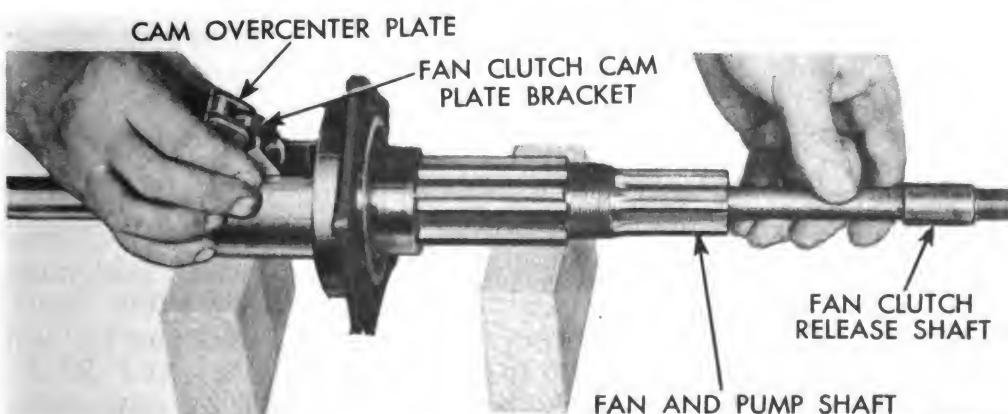
RA PD 20835

Figure 105 — Removing Fan and Pump Shaft Inner Ball Bearing, Using Puller



RA PD 20836

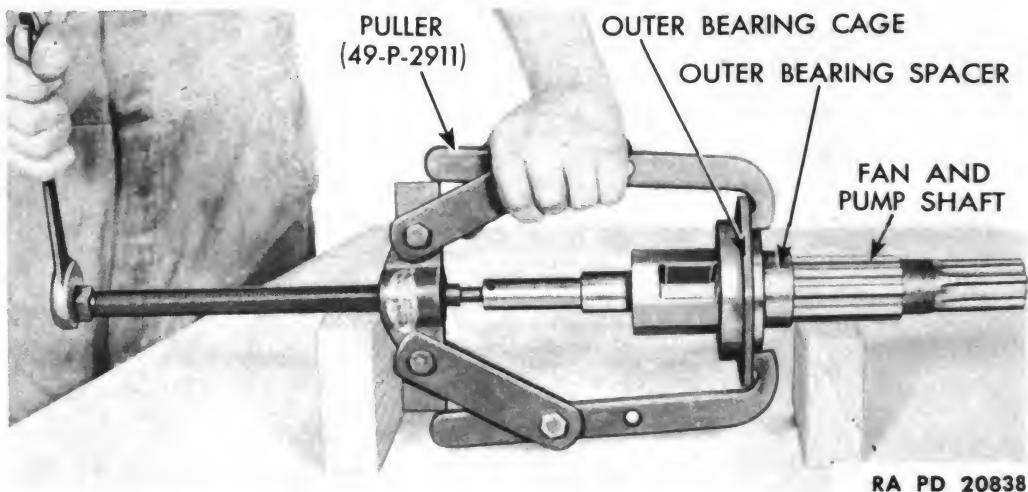
Figure 106 — Removing Cam Plate Bracket Pin



RA PD 20837

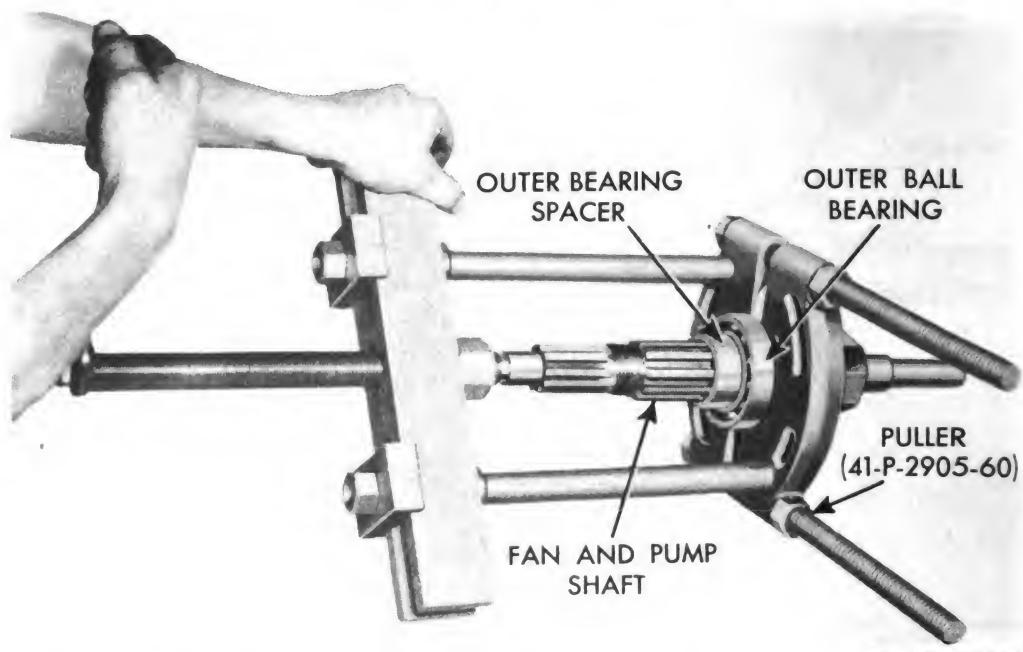
Figure 107 — Removing Fan Clutch Cam Plate Bracket and Release Shaft

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RA PD 20838

Figure 108 — Removing Outer Bearing Cage, Using Puller

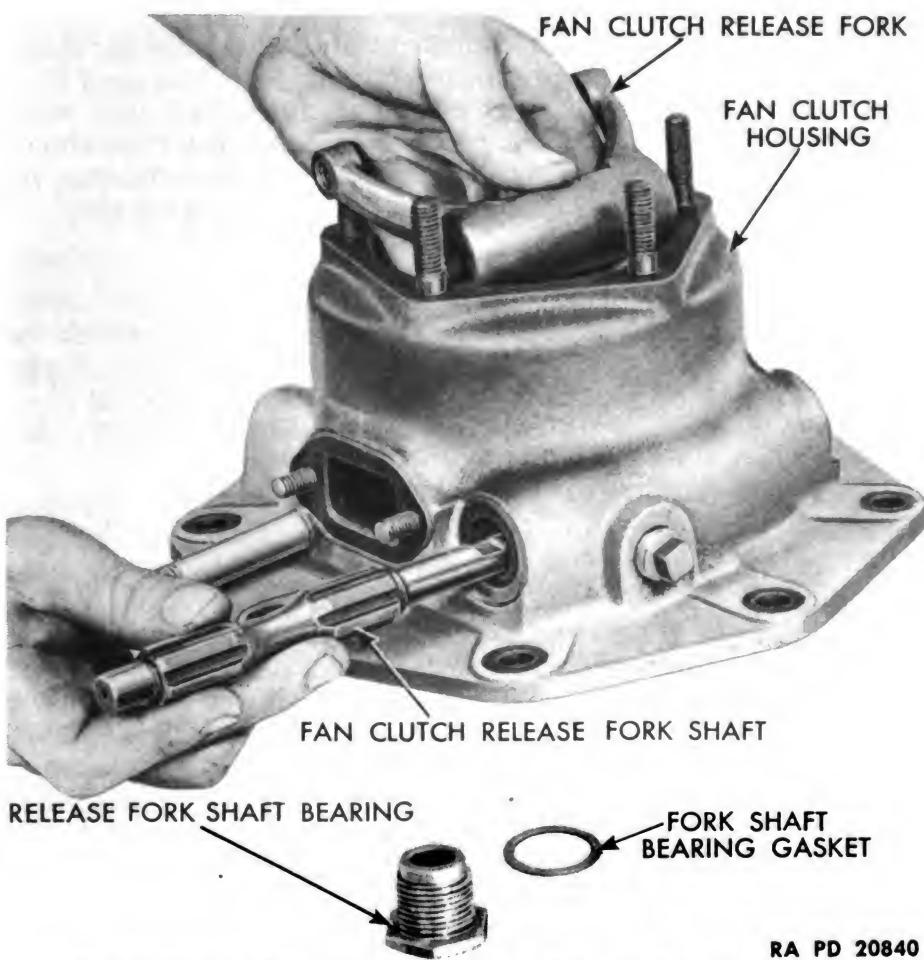


RA PD 20839

Figure 109 — Removing Outer Ball Bearing and Spacer, Using Puller

fan and pump shaft (fig. 105). Remove four cotter pins and four rod end pins; then, lift off two fan clutch cam links (fig. 104). Using a suitable size punch, drive out pin attaching fan clutch cam plate bracket to fan clutch release shaft (fig. 106). Unscrew fan clutch release shaft from fan clutch cam plate bracket, and remove both from fan and pump shaft (fig. 107). Using a puller (41-P-2911), remove outer bearing cage from outer ball bearing (fig. 108). Using a puller (41-P-2905-60) remove outer ball bearing and spacer from fan and pump shaft (fig. 109).

COOLANT PUMP AND FAN CLUTCH



RA PD 20840

Figure 110 — Removing Fan Clutch Release Fork and Shaft

d. Remove Fan Clutch Release Fork. Unscrew release fork shaft bearing with gasket from fan clutch housing, and remove fan clutch release fork shaft and release fork from fan and pump shaft (fig. 110).

44. CLEANING.

a. Strip off gaskets and sealing compound, and wash with dry-cleaning solvent. Remove two pipe plugs from clutch housing, and remove cap from oil level gage nipple (fig. 104). Flush out inside of housing, and blow out with compressed air. Replace plugs and nipple cap.

45. INSPECTION.

a. Examine all surfaces of clutch housing, impeller, outer bearing cage, and outer bearing retainer for cracks. Replace cracked parts. Examine pulley for cracks, particularly at the belt retaining flanges. Examine all studs in clutch housing, and replace if damaged. Examine water seal in hub of impeller. If carbon

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thrust collar is worn or damaged, remove retaining ring, and replace entire seal. Examine outer oil seal and felt seal in pump bearing retainer. If leather is cut or worn, knock out seal, and install new seal with lip or sharp edge of leather towards the engine side. Examine oil seal in fan clutch housing. If damaged, replace with the lip or sharp edge of leather toward the engine side.

46. ASSEMBLY.

a. **Install Clutch Release Fork.** Place the fan clutch release fork inside the fan clutch housing, and insert the release fork shaft into the housing and fork, with the flat side on the end of the shaft toward the engine (fig. 110). Install release fork shaft bearing and new gasket.

b. **Assemble Fan and Pump Shaft Assembly.** Press outer ball bearing into bearing cage. Press outer bearing and cage onto end of fan and pump shaft. Press outer bearing spacer on shaft tightly against outer bearing. Place cam plate bracket into slot in fan and pump shaft, and insert fan clutch release shaft inside fan and pump shaft (fig. 107). Screw clutch release shaft into cam plate bracket as far as possible, then drive in a new attaching pin (fig. 106). Rivet pin on both ends. Place release sleeve on fan and pump shaft, and connect two cam links to release sleeve and cam overcenter plates, inserting four rod end pins and cotter pins (fig. 104). Place inner bearing collar on fan and pump shaft, and press inner bearing on shaft. Place fan clutch release collar in groove in release sleeve.

c. **Install Fan and Pump Shaft Assembly.** Shellac new gasket to front face of fan clutch housing, and insert fan and pump shaft assembly in housing (fig. 104). Secure fan clutch release fork to release collar with two release fork screws and lock washers, working through clutch housing cover openings on either side (fig. 102). Install two fan clutch housing covers with new gaskets, and secure with four nuts and lock washers (fig. 101). Shellac new gasket on outer ball bearing retainer, and install bearing retainer with oil seal (fig. 99). Secure with five nuts and lock washers. Support fan clutch housing in upright position with impeller end up on two blocks of wood. Line up pin holes in impeller with pin hole in shaft, and press impeller onto shaft. Secure impeller to shaft with pin, and rivet both ends of pin.

d. **Install Fan And Pump Pulley.** Slide pulley onto splined end of shaft. Assemble nut lock and nut on shaft, and tighten securely. Bend nut lock over one face of nut.

CHAPTER 3 (Cont'd)

COOLING SYSTEM (Cont'd)

Section III

FAN

	Paragraph
Description	47
Cleaning, inspection, and repair	48

47. DESCRIPTION (fig. 111.)

- a. A 6-blade fan with 28-inch outside diameter is mounted on the fan and coolant pump pulley. When the fan clutch is disengaged as for fording, the fan and pump pulley turns freely in an oilite bushing in the fan hub. When the fan clutch is engaged, the clutch facings engage the fan hub and fan pulley flanges with the flanges which are riveted to the fan blades. The blades are of heavy sheet-steel construction pitched to blow the air out of the rear of the engine compartment.

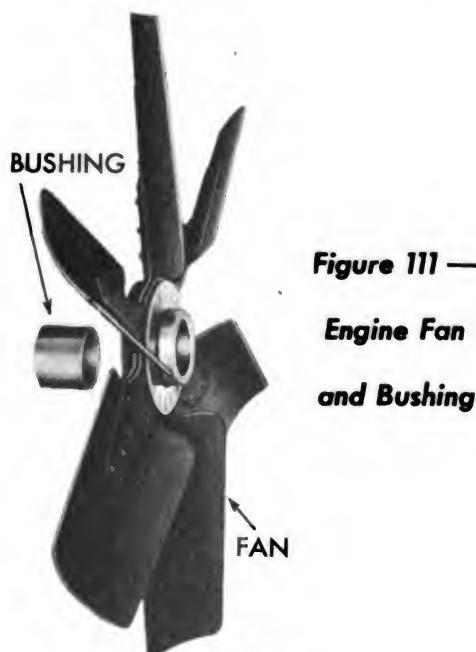


Figure 111 —

Engine Fan

and Bushing

RA PD 20841

- b. Removal, installation, and fan clutch adjustment procedure is described in TM 9-786.

48. CLEANING, INSPECTION AND REPAIR.

- a. Clean fan with steam or dry-cleaning solvent.
- b. Inspect all rivets for looseness. Clinch loose rivets with hammer.

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- c. Inspect oilite bushing for excessive wear. Inside diameter of new bushing is 2.5012 to 2.5032 inches. To replace bushing, drive old bushing out with suitable driver, and drive new bushing in until it is flush with sides of fan hub.
- d. Rotate fan on fan and pump pulley, and observe for run-out in the blades, or for bent blades. Bend blades to aline. Replace fan if run-out cannot be corrected.

CHAPTER 3 (Cont'd)

COOLING SYSTEM (Cont'd)

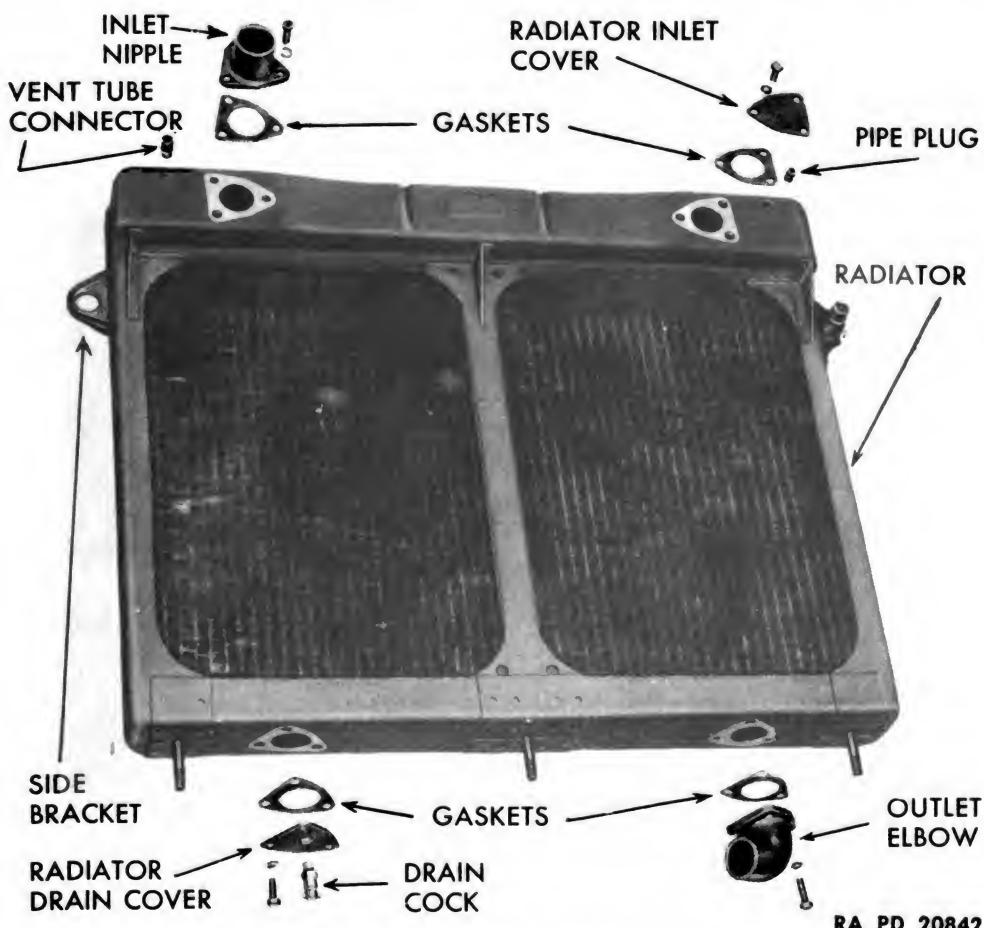
Section IV

RADIATOR

	Paragraph
Description	49
Cleaning and inspection	50
Repair	51
Test	52

49. DESCRIPTION (fig. 112).

a. There are two identical fin-and-tube type radiators used in the cooling system. One is located on each side of the engine compartment. The radiator consists of a top and a bottom tank with the core set in between. The ends of the core tubes are soldered to headers, which in turn are soldered to the tanks.



RA PD 20842

Figure 112 — Left Radiator Components

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Channels are used around the ends, and also at the center front and back of the core, to reinforce the assembly. Radiator parts are fastened together by a combination of rivets, spot welds, and solder. There are two inlet openings in the top tank, and two outlet openings in the bottom tank. A radiator can be used on either side of the engine compartment by merely changing the location of the inlet nipple and outlet elbow on the inlet and outlet openings. The openings which are not being used are closed by covers. The lower cover is equipped with a drain cock.

b. Radiator removal is described in TM 9-786.

50. CLEANING AND INSPECTION.

- a. Clean the radiator inside and out with dry-cleaning solvent, and dry with compressed air.
- b. Examine core for leaks and bent tubes. Repair if damaged (par. 51).
- c. Inspect mounting studs. If they are bent or damaged, replace with new studs (par. 51 c).

51. REPAIR.

- a. Bent fins can be straightened by using a long steel bar. CAUTION: *Be careful not to damage the tubes in this operation.*
- b. Repair leaks by soldering. If they cannot be repaired, replace with new radiator assembly.
- c. Replace bent or damaged mounting studs by turning them out, and installing new studs.
- d. Solder all cracked or broken soldered connections.

52. TEST.

- a. Plug, with radiator inlet covers and gaskets, all inlet and outlet openings except one, which should be covered with a radiator drain cover and gasket. Remove drain cock from drain cover, install a fitting and connect air pressure line to fitting. Install pipe plug in place of vent tube connector. Apply air pressure of 10 pounds per square inch to radiator.
- b. Immerse radiator in water, and observe for air bubbles. Mark leaks, and repair by soldering.

CHAPTER 3 (Cont'd)

COOLING SYSTEM (Cont'd)

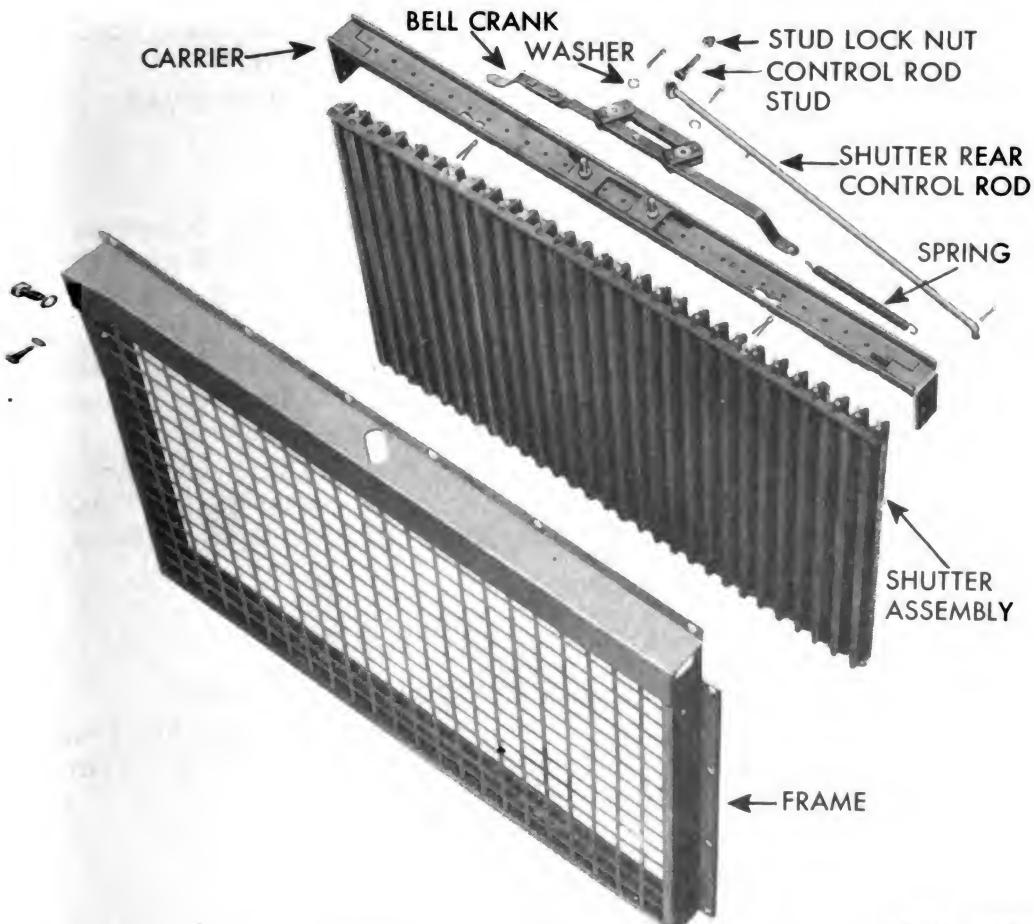
Section V

RADIATOR SHUTTER

	Paragraph
Description	53
Disassembly	54
Cleaning, inspection, and repair	55
Assembly	56

53. DESCRIPTION.

a. Two identical manually-controlled radiator shutters are used on the vehicle. They are located across the outer faces of the radiators. A shutter consists of a series of vertical steel louvers that pivot on the ends to open or close. All louvers are connected to a common operating bar, which turns them in unison. A



RA PD 20843

Figure 113 — Radiator Shutter Components

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RA PD 20844

Figure 114 — Upper End of Radiator Shutter Assembly Pulled Out of Frame

grilled frame holds the assembly together, and is also used for mounting purposes. A bell crank, which is part of the shutter controls, closes the shutter when the control rod is pulled out, and opens the shutter when the control rod is pushed in.

b. Removal and installation are described in TM 9-786.

54. DISASSEMBLY.

a. Remove Shutter Rear Control Rod (fig. 113). Remove lock nut from end of rear control rod stud, and turn out stud through opening provided in top of shutter frame. Remove rear control rod.

b. Remove Shutter Assembly (figs. 113 and 114). Remove two cap screws and lock washers attaching both ends of carrier to frame. Pull shutter assembly out of frame at top.

c. Remove Bell Crank and Carrier (fig. 113). Unhook and remove spring. Remove flat washers and cotter pins attaching bell crank to carrier and shutter operating bar, and remove bell crank and carrier.

55. CLEANING, INSPECTION AND REPAIR.

a. Clean all parts with steam or dry-cleaning solvent.

b. Inspect shutter louvers for damage. Straighten louvers where possible, and rivet over loose trunnions and studs. Replace with new shutter assembly if beyond repair.

c. Straighten grille in frame, if bent.

56. ASSEMBLY.

a. Install Carrier and Bell Crank. Place carrier on top end of shutter assembly, making sure louver trunnions fit into the

RADIATOR SHUTTER

holes provided. Place bell crank onto two carrier studs and two operating bar studs. Install two flat washers over two carrier studs, and insert four cotter pins in the four studs. Hook one end of spring to anchor on carrier, and other end to operating bar stud. Set shutter assembly into frame, with louver trunnions in holes provided at bottom. Move upper end of shutter assembly into frame, and attach with four cap screws and lock washers.

b. Install Shutter Rear Control Rod. Determine whether shutter is to be used on left or right radiator. Then insert rear control rod through opening provided in end of frame which will be toward front of vehicle. Install control rod stud through hole in control rod and into inner bell crank link on left radiator shutter, and to outer bell crank link on right radiator shutter (grille side considered outer side). Install lock nut on lower end of stud.

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CHAPTER 3 (Cont'd)

COOLING SYSTEM (Cont'd)

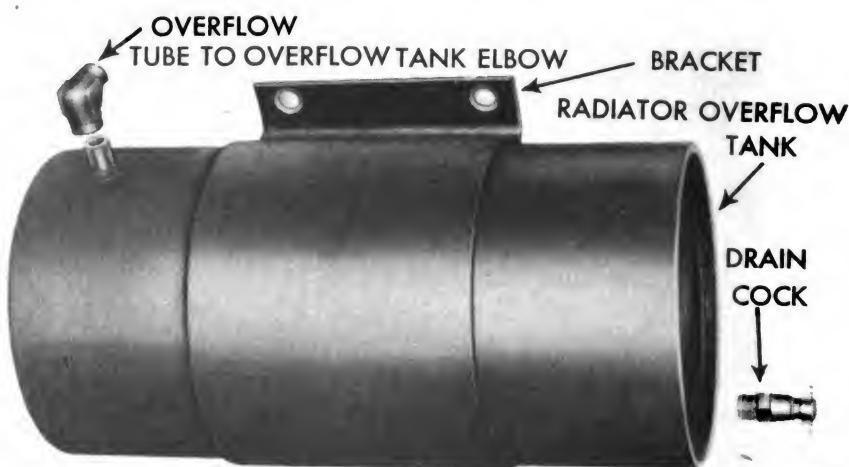
Section VI

RADIATOR OVERFLOW TANK

	Paragraph
Description	57
Repair and test	58

57. DESCRIPTION.

a. The overflow or expansion tank for the cooling system is mounted to the right frame channel below the engine compart-



RA PD 20845

Figure 115 — Radiator Overflow Tank

ment. It is a welded steel tank with a drain cock at one end. It has a bracket that surrounds the tank for mounting purposes (fig. 115). The tank is connected to the cooling system through an overflow tube that extends down to the bottom of the tank. When the cooling system heats up, the resulting pressure opens the release valve so that coolant drains out through the overflow tube into the overflow tank. If the tank becomes filled, any additional coolant drains out through an overflow pipe in the tank. As the cooling system cools, the coolant in the overflow tank is sucked back into the system.

b. Removal and installation are described in TM 9-786.

RADIATOR OVERFLOW TANK

58. REPAIR AND TEST.

- a. Repair any leaks by welding. A loose bracket must be rewelded to tank.
- b. Test tank in water with air pressure of 8 to 12 pounds. Insert plug in tank overflow pipe opening, and connect air line to overflow tube. NOTE: *Air bubbles indicate location of leaks.*

CHAPTER 4

FUEL SYSTEM, GOVERNOR, AND AIR CLEANER

Section I

DESCRIPTION

	Paragraph
Description and operation	59

59. DESCRIPTION AND OPERATION.

a. Description.

(1) The fuel system consists of two fuel tanks, a fuel filter for each tank, fuel tank selector valve with water trap and strainer, fuel pump with water trap and strainer, fuel pump hand primer, two carburetors, starting hand primer system, and necessary connecting tubing. The fuel system is sealed except for the vent and overflow tubing which connect the two fuel tanks to the air cleaner and to an overflow tube. This arrangement permits the gasoline fumes and odors to be drawn into the engine through the air cleaner thereby eliminating fire hazard and gasoline odors. It also permits the fuel to expand out through the overflow tube when the tanks are completely filled. The overflow is located above the fuel tanks, thereby permitting the tanks to be submerged below the water when fording without danger of water entering the tanks. Refer to TM 9-1828A for information on fuel pump. Refer to TM 9-1826C for information on down-draft carburetors.

(2) The governor limits the full-load speed and high-idle speed of the engine. It is a mechanical flyweight-type governor, located below the distributor, and connected by linkage to two butterfly valves, one in each throttle body. The butterfly valves limit the intake of fuel and air mixture into the intake manifolds, and hold maximum engine speed under full-load to 2,900 revolutions per minute, and maximum high-idle speed to 3,050 revolutions per minute.

(3) The air cleaner provides clean air to the two carburetors and to the air compressor, and in addition it vents the fuel tanks. The air cleaner is a heavy-duty, 12-inch, oil-bath type. It is mounted in the left front corner of the engine compartment.

b. Operation. Either fuel tank can be selected to feed the system by turning the selector valve knob below the driver's seat. The gasoline leaves the tank through an outlet pipe which is part of a sender unit. It then passes through a tube to the fuel filter, located behind the driver's seat, where all dirt particles are removed. From the filter the gasoline flows through a tube to the

DESCRIPTION

selector valve, which has a water trap and screen where water is removed. The fuel then flows through a tube to another water trap and screen on the fuel pump and on into the fuel pump proper. The fuel pump, which is mounted to the distributor side of the engine, forces the gasoline up to the two carburetors mounted on top of the intake manifolds. The starting primer system consists of a manually-operated plunger-type primer pump which receives gasoline through a tube connected to a tee located in the fuel line directly ahead of the fuel pump. The primer pump delivers the fuel to a distributor tee, from which a series of small tubes carry the fuel to the intake manifolds, where it is injected in six separate sprays. In the event the fuel should drain back from the carburetors through the fuel pump, which is at a lower level, it is possible to prime the system by moving the hand primer rod, connected to the fuel pump, up and down. This rod operates the fuel pump and primes the system. An electrically operated fuel gage on the dash will indicate the amount of gasoline in each fuel tank when the ignition switch is turned on and a toggle switch is tripped to the left or right.

CHAPTER 4 (Cont'd)

FUEL SYSTEM, GOVERNOR, AND AIR CLEANER (Cont'd)

Section II

FUEL TANK

	Paragraph
Description	60
Cleaning, inspection and repair	61
Test	62

60. DESCRIPTION (fig. 116).

a. Two 50-gallon capacity fuel tanks are provided. They are located on opposite sides of the shell box below the center side platform doors. The tanks are of welded-steel construction with large filler openings which include flame arresters. Filler caps and flame arresters are screw type. Inside each tank are two sheet-steel baffles. A drain plug is provided at the bottom of each tank. The tanks are supported in the vehicle on the left and right center bottom plates and are attached to these plates and also to the fender side sheets by cap screws with lock washers which screw into lugs welded to the tanks.

b. Removal and installation of fuel tanks are described in TM 9-786.

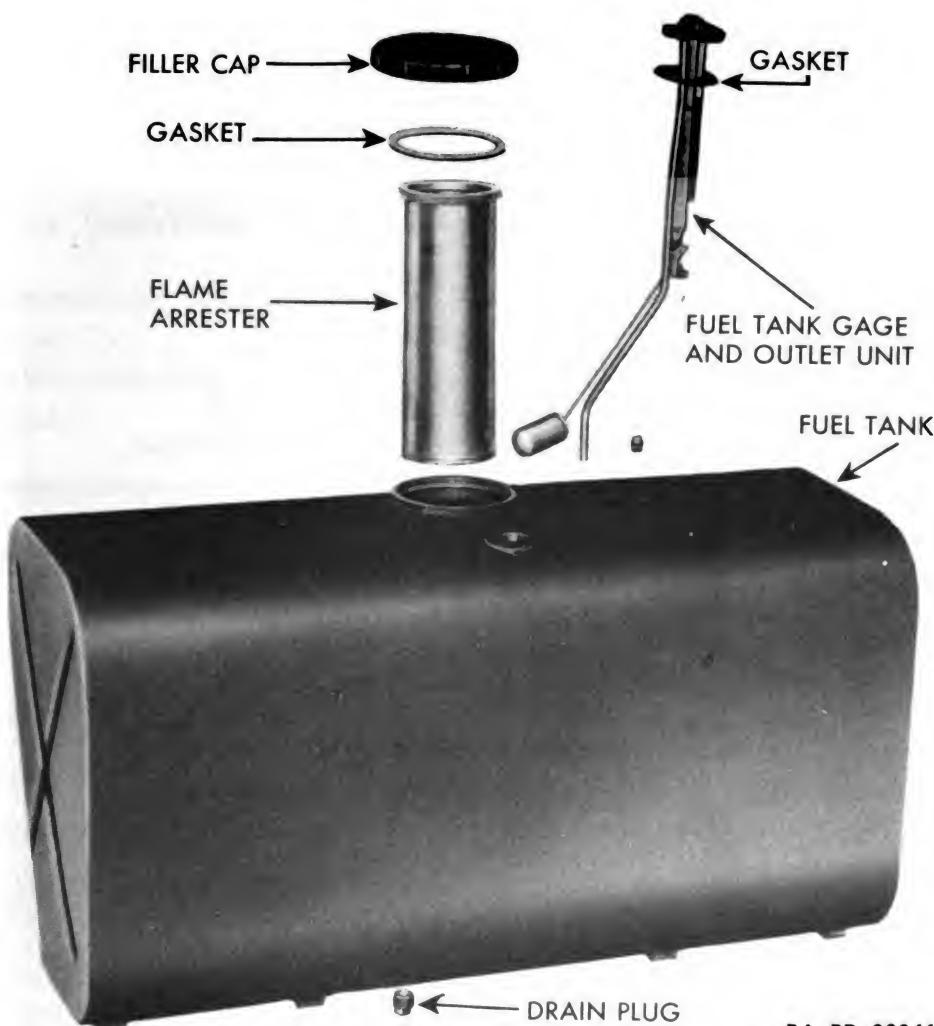
61. CLEANING, INSPECTION AND REPAIR.

a. Drain fuel tank. Unscrew flame arrester from filler opening. Clean outside and inside of tank with dry-cleaning solvent or steam. Dry the tank thoroughly with compressed air.

b. Inspect inside of tank for dirt. If dirt has not been removed after cleaning, and has accumulated to a point where it is impossible to remove with further cleaning, replace the tank with a serviceable one. Inspect mounting screw lugs for secure welding to tank, and inspect for leaks.

c. As a precaution, the tank must be thoroughly drained and blown out with compressed air before repairing. Care must be taken when handling fuel tanks to avoid producing a spark that may ignite the volatile mixture of air and fuel. Repair leaks by first gouging out material at leak, and then welding. Tack-weld loose spacers to bottom of tank. If leak is between spacer and tank, break the spacer loose from the tank with a chisel and hammer, repair leak by welding, and then tack-weld spacer back into place, making sure holes in spacer line up with mounting screw holes in lugs.

FUEL TANK



RA PD 20846

Figure 116 — Fuel Tank and Gage with Outlet Unit

d. Inspect the bottom of fuel tank for corrosion that might cause a rupture. Use following method of checking. NOTE: This method can also be used while installing fuel tank in the vehicle.

- (1) Drain the fuel tank until 1 inch of fuel remains in the tank.
- (2) Remove filler cap, and screw out flame arrester.
- (3) Insert a metal rod ($\frac{1}{4}$ to $\frac{1}{2}$ inch in diameter, approximately 5 feet long, and round on end) through the filler hole, and tap smartly over all corroded areas on the inside bottom of the fuel tank. CAUTION: To preclude the possibility of igniting the fuel vapor in the tank, by a static discharge from the metal rod, the rod should be properly grounded to the vehicle before being inserted in the fuel tank. If the corroded area is thin, the rod will puncture the bottom of the fuel tank, or at least puncture the metal sufficiently to start a leak.

**ORDNANCE MAINTENANCE -- ENGINE, ENGINE ACCESSORIES, CLUTCH GROUP,
AND PROPELLER SHAFT FOR 13-TON, HIGH-SPEED TRACTOR M5****62. TEST.****a. Wet Method.**

- (1) Plug tightly all openings except filler neck, and tank gage and outlet unit openings.
- (2) Dry entire outer surface of tank with compressed air or clean, dry cloth.
- (3) Place the tank on blocks so that its under side can be seen.
- (4) Fill tank with water, and install filler cap.
- (5) Insert the end of an air hose in the tank gage and outlet unit opening, and cover rest of opening with a cloth.
- (6) Apply air pressure on the water for a few minutes.
- (7) Examine entire outer surface of tank for moist spots where the water was forced through.

b. Air Pressure Method.

- (1) Plug all openings except drain plug opening.
- (2) Attach end of air supply hose to this opening.
- (3) Submerge the fuel tank in a tank of water, or cover the entire tank with soapy water.
- (4) Turn on air pressure of 10 pounds per square inch.
- (5) Draw a ring around each spot on fuel tank where bubbles appear. NOTE: *Bubbles indicate leaks.*

CHAPTER 4 (Cont'd)**FUEL SYSTEM, GOVERNOR, AND
AIR CLEANER (Cont'd)****Section III****FUEL TANK SELECTOR VALVE**

	Paragraph
Description	63
Disassembly	64
Cleaning, inspection, and repair	65
Assembly	66

63. DESCRIPTION (fig. 117).

a. This valve is mounted on the inside of the driver's seat front support, and is controlled by a knob located on the outside of the front support, within easy reach of the driver. The valve has three positions: when the pointer on the knob points up, the fuel from both fuel tanks is shut off; when it points to the left or right, the valve opens the fuel supply from either the left or right fuel tank. The valve consists of a body which contains two spring-seated valve stems, operating cam, fuel strainer screen, and bowl.

b. Fuel enters the selector valve through two inlet ports located at the top of the valve body. These ports are connected through tubing to the left and right fuel tanks. The flow of fuel through the valve body is shut off by two valve stems which are held closed by compression springs. A cam, located in the center of the valve body, operates the valve stems. The outer end of the cam has a flat spot to locate the control knob pointer, and also to lock the knob on the cam. When the flat spot is horizontal, both valve stems are closed. When it is turned to the right, one valve stem opens and permits fuel to flow by the valve. When it is turned to the left, the other valve stem opens and permits fuel to flow by the valve. Only one valve stem is open at one time. After passing the valve stem, the fuel goes through a baffle which is located in the center of the screen bowl. This baffle breaks up the flow of fuel, and prevents stirring up of sediment in the bottom of the bowl. From the bowl the fuel passes up through a fine mesh screen, and out through an outlet port which is connected to the fuel pump inlet through a tube.

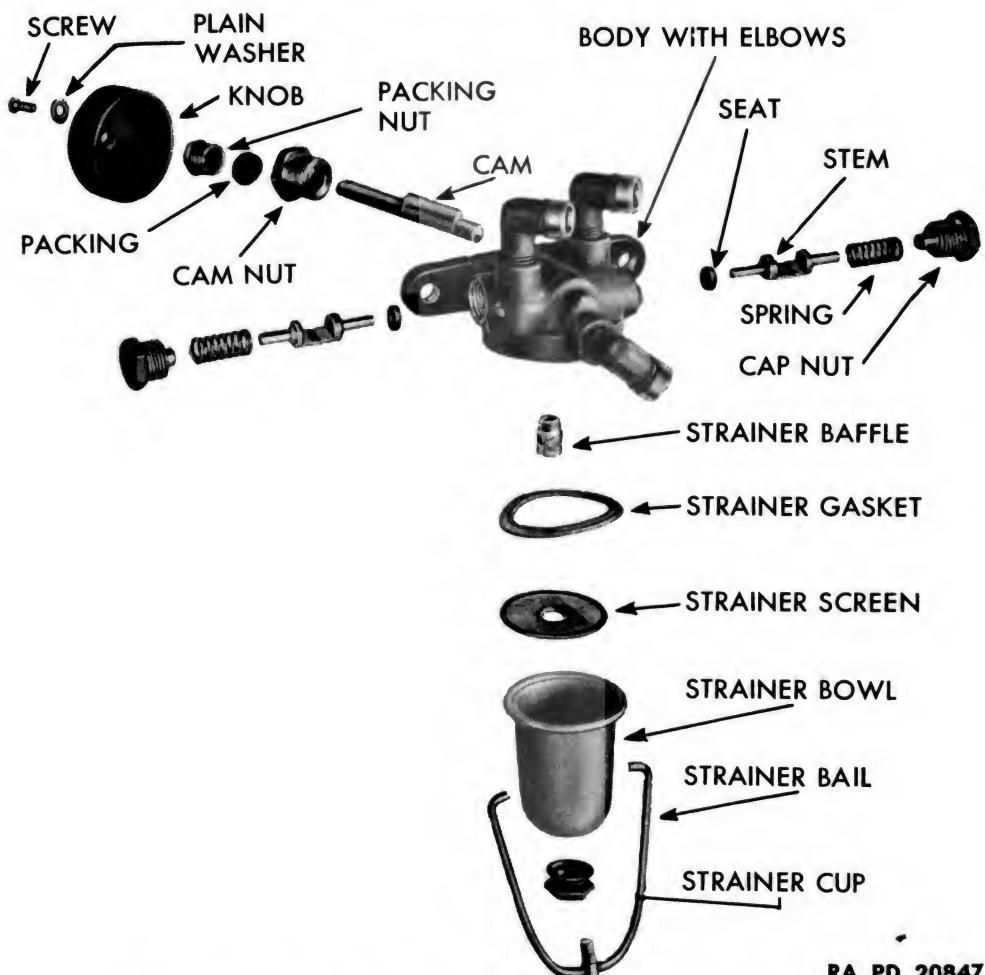
c. Removal and installation are described in TM 9-786.

64. DISASSEMBLY.

a. **Remove Screen Bowl.** Loosen cup at bottom of bowl, swing bail aside, and remove bowl, screen, and cork gasket.

b. **Remove Cam.** Unscrew the cam nut, with packing nut and packing, from the valve body, and remove cam.

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AND PROPELLER SHAFT FOR 13-TON, HIGH-SPEED TRACTOR M5



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Figure 117 — Fuel Tank Selector Valve Components

c. Remove Valve Stems. Unscrew cap nut from body, and remove spring and valve stem assembly. Repeat operation to remove second stem assembly.

d. Remove Bail and Baffle. Pull one end of bail wire out of hole in valve body, move it aside to clear body, and remove bale assembly. Unscrew baffle from body with pliers.

65. CLEANING, INSPECTION AND REPAIR.

a. Clean all parts of valve in dry-cleaning solvent, and dry with compressed air.

b. Inspect body for cracks or damaged threads, also inspect valve stem seats in body for scratches or nicks. Replace with new body if any of these defects are present.

c. Inspect strainer screen and strainer cork gasket. Replace defective screen or gasket.

FUEL TANK SELECTOR VALVE

66. ASSEMBLY.

- a. Install Bail and Baffle.** Screw baffle into valve body, and tighten. Insert bent end of bail wire in hole provided in side of valve body. Spread wire far enough to insert other bent end into hole in opposite side of valve body.
- b. Install Valve Stems.** Insert valve stem into hole in valve body, with packing washer end in first, and with flat surface up. Install spring and cap nut. Repeat operation for second valve stem, spring, and cap nut.
- c. Install Cam.** Place cam into hole in valve body, over flat surfaces on valve stems, and into inner hole. Loosen packing nut in cam nut, and install both over cam. Turn cam nut into valve body, and tighten securely. Tighten packing nut just enough to prevent leakage past the packing.
- d. Install Screen Bowl.** Place screen and cork gasket on top of bowl, and hold bowl in place below valve body. Swing bail down, and tighten cup against bowl.

CHAPTER 4 (Cont'd)

FUEL SYSTEM, GOVERNOR, AND AIR CLEANER (Cont'd)

Section IV

FUEL FILTER

	Paragraph
Description and operation	67
Disassembly	68
Cleaning, inspection, and repair	69
Assembly	70

67. DESCRIPTION AND OPERATION (fig. 118).

a. Two fuel filters, one for each fuel tank, are mounted on the back of the driver's seat behind the back rest. Each filter is connected into the fuel line between a fuel tank and the selector valve. The filter consists of a metal element which is cleaned by a revolving knife. The knife is rotated by the turning of a ratchet handle on top of the filter in a clockwise direction. It scrapes the accumulation from the outside surface of the element. Surrounding the element is a case which collects the dirt that falls from the element. The case and element are attached to a head which is also used for mounting. Fuel enters an inlet passage in the head, flows down around the outside of the element, through the 0.002-inch spacings in the element, up into the head, and out through the outlet port.

b. Removal and installation are described in TM 9-786.

68. DISASSEMBLY.

a. Remove element with knife. Refer to TM 9-786.

69. CLEANING, INSPECTION AND REPAIR.

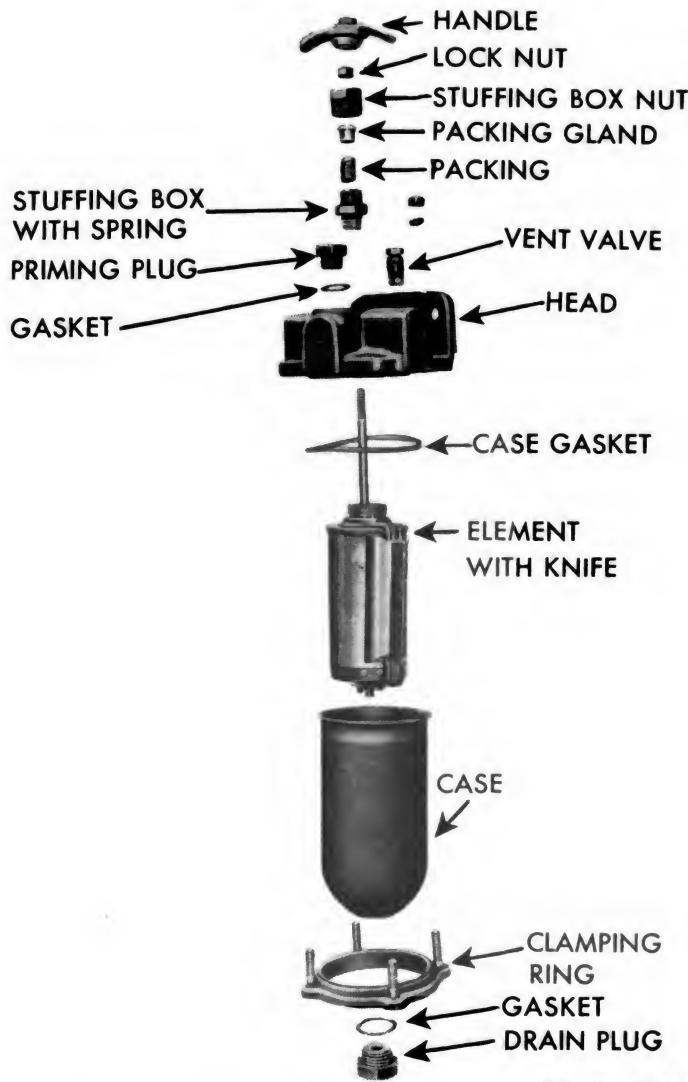
a. Clean all parts in dry-cleaning solvent, and dry with compressed air.

b. Inspect element for breaks; if defective, replace with complete new element with knife assembly.

c. Inspect contact of knife on element. If knife does not contact element evenly, remove cotter pin from end of knife shaft, and remove shaft, knife and knife driver. Straighten knife blade until it contacts element evenly for its full length. Then install knife, driver, shaft, and cotter pin on element.

d. Inspect spring on stuffing box. If it does not contact serra-

FUEL FILTER



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Figure 118 — Fuel Filter Components

tions of stuffing box nut, remove nut, and bend spring prongs in; then install nut.

e. Inspect filter case gasket. Replace with a new one if damaged.

70. ASSEMBLY.

a. Install element with knife. Refer to TM 9-786.

CHAPTER 4 (Cont'd)

FUEL SYSTEM, GOVERNOR, AND AIR CLEANER (Cont'd)

Section V

FUEL TANK GAGE WITH OUTLET UNIT

Paragraph

Description	71
Inspection and repair	72

71. DESCRIPTION (fig. 116).

a. This unit is located in each fuel tank and registers the amount of fuel in the tank. A float attached to a long arm actuates a sender unit which varies the amount of current delivered to the fuel gage on the instrument panel as the fuel level varies. The fuel tank outlet is a part of this unit.

b. Removal and installation procedures are described in TM 9-786.

72. INSPECTION AND REPAIR.

a. Inspect fuel tank gage float for leaks. If a leak has developed in float, remove all fuel or traces of fuel vapor, and repair leak by soldering. Inspect fuel outlet tube for being clogged with dirt, or having a leak at solder joint at top. Repair leak by soldering. If fuel tank gage and outlet unit is otherwise damaged, or does not register fuel level in tank, replace with new unit.

CHAPTER 4 (Cont'd)**FUEL SYSTEM, GOVERNOR, AND
AIR CLEANER (Cont'd)****Section VI****AIR CLEANER**

	Paragraph
Description and operation	73
Disassembly	74
Cleaning, inspection, and repair	75
Assembly	76

73. DESCRIPTION AND OPERATION (fig. 119).

a. Description. The air cleaner is a heavy-duty, 12-inch, oil-bath type. It is located in the left-front corner of the engine compartment, and secured to the side sheet by mounting brackets. It provides clean air to the engine carburetors and air compressor. In addition, it vents the fuel tanks, thus reducing the possibility of fire from gasoline vapor, and preventing gasoline odor. The air cleaner must be removed and cleaned after every 100 hours of operation.

b. Operation. Air enters the cleaner from the top through a screen which prevents coarse particles from entering with the air. The air passes down through the center of the air cleaner to the oil cup at the bottom. Here its direction is reversed, causing the dust and dirt to separate from the air and settle in the oil. As the air flows up, it carries an oil mist which is deposited on the screen elements as it passes through. Additional dust is removed by the oil film on the screen elements. The dust is carried down by the oil returning to the oil cup.

c. Removal and installation procedures are described in TM 9-786.

74. DISASSEMBLY.

a. Remove cover from top of cleaner by loosening wing screw. Unscrew tie bolt from oil cup, and remove bolt and oil cup. Remove wing nut securing two bottom screens to cleaner body. Remove four cap screws and lock washers attaching intake screen and supporting sheet to cleaner body. Remove intake screen.

75. CLEANING, INSPECTION AND REPAIR.

a. Clean. Clean all parts thoroughly with dry-cleaning solvent. Be sure to clean the screens in cleaner body and air intake tube.

b. Inspect and Repair. Inspect body, cover, and oil cup for breaks and dents which would cause air leaks and allow dust to enter, causing failure of engine. Replace badly damaged parts,

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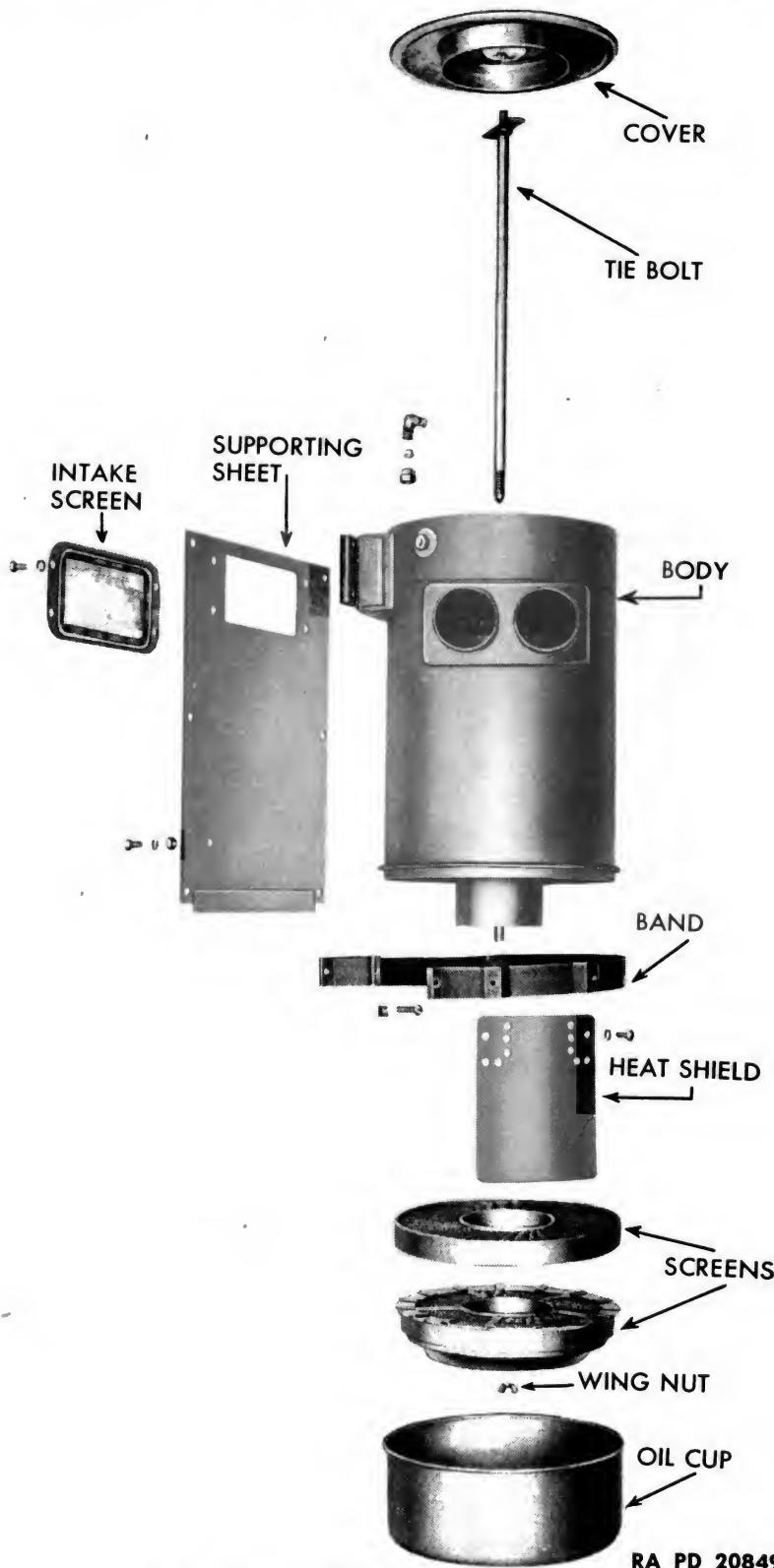


Figure 119 — Air Cleaner Components

AIR CLEANER

weld breaks, and straighten dents. Inspect individual screens in body for accumulation of lint, chaff, or leaves. Replace defective screens, and replace body if clogged. Inspect intake screen, and replace if broken. Inspect tie bolt threads and threads in oil cup, and replace if damaged.

76. ASSEMBLY.

- a. Install two individual screens in bottom of cleaner body, and secure with wing nut. Set cleaner body on oil cup, and attach by inserting tie bolt down through cleaner body. Tighten tie bolt against two bolt support brackets. Install cover on top of cleaner, and secure with wing screw. Attach intake screen and support sheet to bracket on cleaner body with four cap screws and lock washers.

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AND PROPELLER SHAFT FOR 13-TON, HIGH-SPEED TRACTOR M5**

CHAPTER 4 (Cont'd)

**FUEL SYSTEM, GOVERNOR, AND
AIR CLEANER (Cont'd)**

Section VII

GOVERNOR

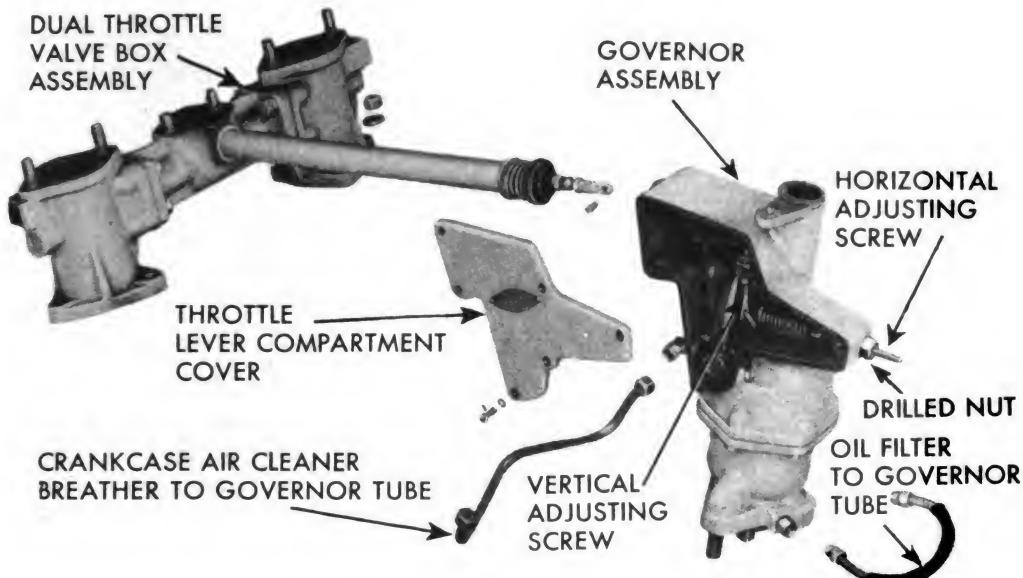
	Paragraph
Description	77
Disassembly	78
Cleaning, inspection, and rebuilding	79
Assembly	80
Adjustment	81

77. DESCRIPTION (fig. 120).

a. The complete governor includes both the governor assembly and the dual throttle valve box assembly. The governor assembly is mounted on top of the governor drive shaft housing, which is attached to the distributor side of the crankcase. The governor drive shaft is driven through a spiral gear off the engine camshaft. The spider shaft assembly, which contains the governor weights, is driven off the top end of the governor drive shaft through a splined coupling. Mounted on top of the governor body is the distributor which is driven off the upper end of the spider shaft through a slotted connection. Located on the opposite side of the engine, between the intake manifold and carburetors, is the dual throttle valve box assembly. This assembly is connected to the governor assembly by a connecting rod, which is located inside of a tube. Lubrication is furnished to the governor assembly and governor drive shaft assembly through a tube which permits a continuous flow of lubricating oil from the filter base to a bushing in the governor base. From this bushing the oil flows through a drilled passage in the spider shaft to lubricate the governor weight assembly. Another tube connects the governor body to the crankcase air cleaner breather, permitting the oil fumes in the governor assembly to be drawn into the crankcase.

b. The governor limits the full-load speed and high-idle speed of the engine. It is a flyweight type Pierce governor. The governor shaft carries a spider to which are hinged two weights. When the engine is operating at speeds below that for which the governor is set, the tension of a spring exceeds the centrifugal force exerted by the weights, and the throttle lever remains in the open position. Inasmuch as the two butterfly valves in the valve box assembly are connected by a shaft and rod to the throttle lever, they also remain wide open. When the engine reaches the speed

GOVERNOR



RA PD 20850

Figure 120 — Complete Governor

for which the governor is set, the centrifugal force of the weights exceeds the tension of the spring, and the weights move out. This moves a sleeve and a yoke upward, and moves the throttle lever and butterfly valves toward a closed position, thus reducing the amount of fuel and air mixture delivered to the engine. The governing system is entirely separate from the carburetor throttle, not being connected to it in any way. The governor simply serves to restrict the flow of fuel and air mixture to the cylinders, thus limiting the speed of the engine when the manually operated throttle valves are open to a point that will give an excessive engine speed under existing-load or no-load conditions. Maximum high-idle engine speed is 3,050 revolutions per minute, and maximum full-load speed is 2,900 revolutions per minute.

78. DISASSEMBLY.

a. Disassemble Governor Assembly.

(1) REMOVE THROTTLE LEVER SPRING (fig. 121). Remove drilled nut from horizontal adjusting screw. Unhook spring from vertical adjusting screw, and remove spring and adjusting screw with lock nut and lock washer from body.

(2) REMOVE BASE (fig. 121). Remove snap ring and washer from splined end of spider shaft. Remove six screws and lock washers attaching base to body. Separate base from body, and remove base. Strip gasket off base.

(3) REMOVE SPIDER SHAFT ASSEMBLY (fig. 121). Unscrew elbow and slotted plug from body. Drive tapered pin out of throttle lever, using a small punch through the slotted plug hole in body. Loosen set screw nut, and remove set screw from side

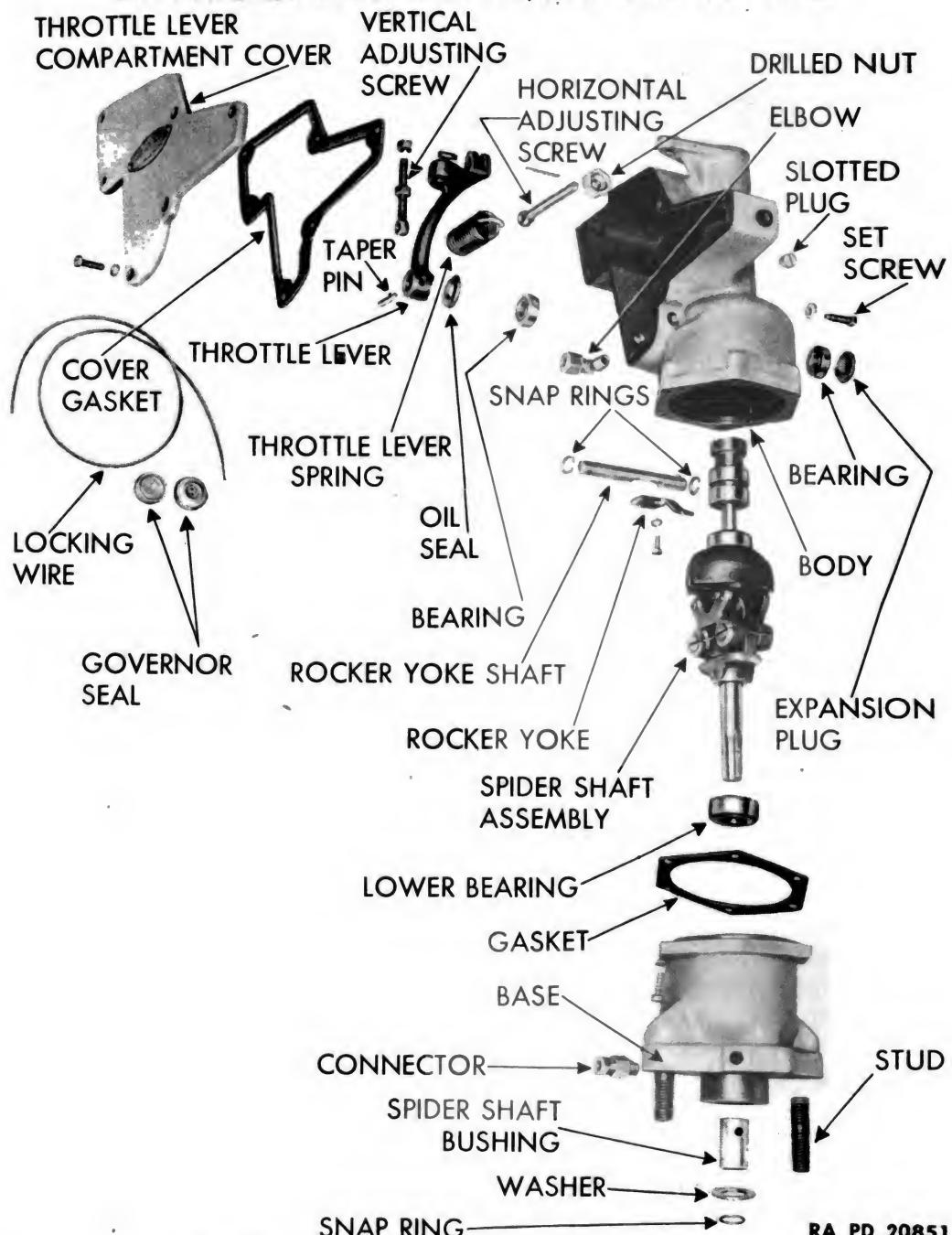
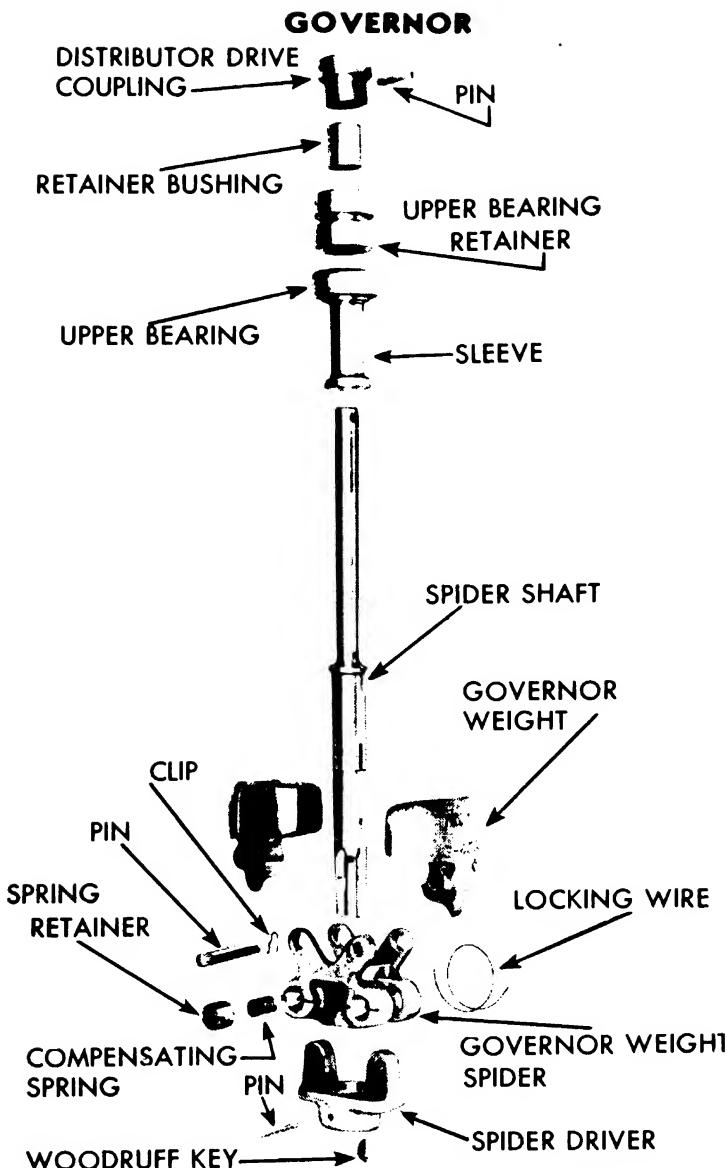
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Figure 121 — Governor Assembly Components

of body. Pull spider shaft assembly out of body. NOTE: *It may be difficult to pull the spider shaft assembly out, as it must force the rocker yoke shaft to turn in the throttle lever.* If it is difficult to pull shaft out, drive on the distributor coupling end of spider shaft with a long brass rod to remove it from the body.

(4) REMOVE ROCKER YOKE SHAFT AND BEARINGS (fig. 121). Remove two cap screws and lock washers attaching rocker yoke to



RA PD 20852

Figure 122 — Spider Shaft Assembly Components

shaft, and remove yoke. Using a punch, and working from throttle lever side of body, drive the rocker yoke shaft out. This removes the throttle lever expansion plug and one bearing at the same time. Remove bearing from shaft, and use shaft to drive the other bearing and oil seal out from the body. Remove two snap rings from rocker yoke shaft with a screwdriver.

(5) REMOVE LOWER BEARING (fig. 121). Press bearing off splined end of spider shaft.

(6) REMOVE DISTRIBUTOR DRIVE COUPLING (fig. 122). Drive pin out of distributor drive coupling. Press coupling off spider shaft. Remove upper bearing retainer and sleeve with upper bearing from shaft. Press upper bearing off sleeve.

(7) REMOVE GOVERNOR WEIGHTS (fig. 122). Remove clips from governor weight pins, and remove pins and weights.

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(8) REMOVE COMPENSATING SPRINGS (fig. 122). Break locking wire on retainers, and remove four spring retainers and springs.

(9) REMOVE SPIDER (fig. 122). Drive pin out of spider driver. Separate the spider and driver, and place shim or bar stock between them. Press spider shaft through spider driver until the spider contacts the Woodruff key. Then add more spacing between spider and driver, and repeat pressing operation until driver comes free. Remove Woodruff key from shaft, and slide spider off shaft.

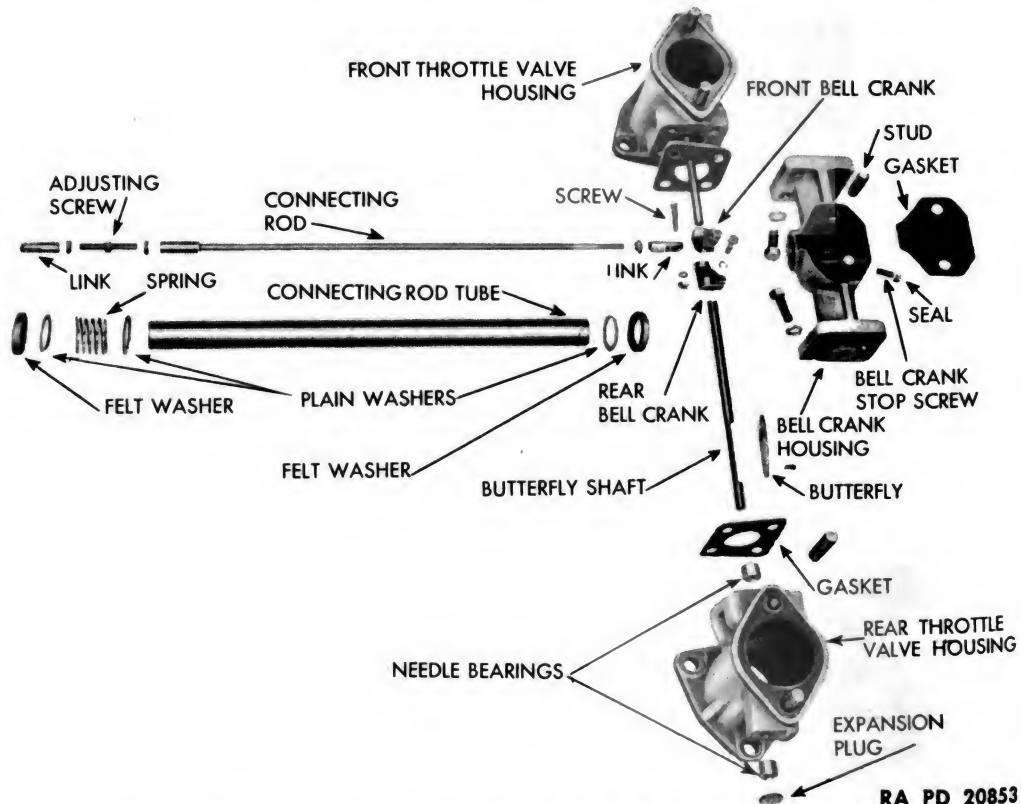


Figure 123 — Dual Throttle Valve Box Assembly Components

b. Disassemble Dual Throttle Valve Box Assembly.

(1) REMOVE CONNECTING ROD TUBE (fig. 123). Pull connecting rod tube from bell crank housing and remove. Remove felt washers, plain washers, and spring from tube.

(2) REMOVE THROTTLE VALVE HOUSINGS (fig. 123). Loosen the locking cap screws in both bell cranks. Remove eight cap screws and lock washers attaching both throttle valve housings to bell crank housing, and remove both throttle valve housings.

(3) REMOVE CONNECTING ROD AND BELL CRANKS (fig. 123). Remove nut, lock washer and screw attaching connecting rod link to bell cranks. Remove connecting rod and bell cranks from bell crank housing.

(4) REMOVE BUTTERFLY SHAFTS (fig. 123). Remove two

GOVERNOR

screws attaching each butterfly to shaft, and lift out butterflies. Press butterfly shafts through housings, and remove expansion plugs.

(5) REMOVE NEEDLE BEARINGS (fig. 123). It is necessary to destroy the needle bearings to remove them. They should, therefore, be removed only if they must be replaced.

79. CLEANING, INSPECTION AND REBUILDING.

a. Clean and Inspect.

(1) Clean all parts in dry-cleaning solvent, and dry with compressed air.

(2) Inspect spider shaft for wear where it contacts bushings. Replace shaft if worn.

(3) Inspect all ball bearings for wear or roughness, and replace if damaged.

(4) Check sleeve for wear where it contacts the weight noses, and for roughness on the inside. Replace if rough or worn.

(5) Check rocker yoke for wear or fracture, and replace if defective.

(6) Inspect weight noses for wear where they contact sleeve, and replace weights if worn.

(7) Check bushings in retainer and base for wear. Replace worn bushings.

(8) Replace all gaskets.

b. Rebuild.

(1) BASE (fig. 121). Press spider shaft bushing out. Press new bushing in with slotted hole in bushing alined with oil hole in base. Line-ream bushing to 0.624 to 0.625 inch. Bushing hole must be concentric within 0.002 inch of flange face on top of base. NOTE: *Attach governor base to body with upper bearing retainer in place. The upper bearing retainer can then be used to pilot reamer for proper concentricity.*

(2) UPPER BEARING RETAINER (fig. 122). Press bushing out of upper bearing retainer. Press new bushing in with chamfered end in first. Ream bushing to 0.438 to 0.439 inch.

(3) THROTTLE VALVE HOUSING (fig. 123). Drive needle bearing out, using a bent rod. Needle bearing will be destroyed in this operation. Carefully drive new needle bearing in. Make sure rollers are free when bearing is installed.

(4) SPIDER DRIVER AND SHAFT (fig. 122). When a new spider driver or spider shaft is needed, it will be necessary to drill both for a pin. Place governor weight spider on shaft. Install Woodruff key in shaft. Press spider driver on shaft until there is 0.005-inch clearance between spider and driver. Drill through spider driver and shaft with $\frac{1}{8}$ -inch drill. NOTE: *This hole should be drilled to one side of center line of the shaft to avoid plugging the oil passage in the shaft.* Install pin.

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AND PROPELLER SHAFT FOR 13-TON, HIGH-SPEED TRACTOR M5**

(5) **DISTRIBUTOR DRIVE COUPLING AND SHAFT** (fig. 122). When a new distributor drive coupling or shaft is needed, it is necessary to drill a pin hole in both. Press coupling on shaft, and line up slot in coupling with splined flutes on lower end of shaft. This is important. Drill with $\frac{5}{32}$ -inch drill for pin.

(6) **THROTTLE LEVER** (fig. 121). When new throttle lever and new rocker yoke shaft are installed, it is necessary to drill and ream a hole in both for a tapered pin. Have the governor assembly assembled completely except for the throttle lever, spring, and horizontal adjusting screw. Position the throttle lever on the rocker yoke shaft so that it will contact the inside wall of the lever compartment nearest the throttle connecting rod hole. To position the lever correctly, set the base on parallel bars on a surface plate. Adjust a protractor (41-S-4541) to read 5 degrees. Set the protractor on the parallel bars or surface plate, and force the throttle lever in a clockwise direction until the center line of the lever is parallel to the protractor scale (fig. 124). Insert a drill through the slotted plug tapered hole in the body, and drill a hole through the lever and shaft with a No. 25 drill. Ream with a No. 1 tapered reamer to fit tapered pin.

80. ASSEMBLY.**a. Governor Assembly.**

(1) **INSTALL SPIDER** (fig. 122). Place spider on shaft. Install Woodruff key, and press spider driver on shaft until there is 0.005-inch clearance between spider and spider driver. Install pin, and rivet over ends to lock in place.

(2) **INSTALL GOVERNOR WEIGHTS** (fig. 122). Place weights in spider, and install pins and clips. Press upper bearing on sleeve, and place sleeve on shaft. Try weights for movement. The sleeve should move $\frac{1}{4}$ inch as the weights swing from closed to wide-open position. If the travel is less than the required $\frac{1}{4}$ inch, remove weights and grind off stock from the weight stop tips. Do not remove more stock than is necessary to obtain the specified travel, or the weights will strike the case when they reach the wide-open position.

(3) **INSTALL COMPENSATING SPRINGS** (fig. 122). Install four springs in spider, and secure with spring retainers. Turn retainers in until one thread on each retainer still shows. Adjust retainers until the spider driver is centered in the spider. Lock the retainers in this position with locking wire.

(4) **INSTALL DISTRIBUTOR DRIVE COUPLING** (fig. 122). Place sleeve with upper bearing and upper bearing retainer on shaft. Press distributor drive coupling onto shaft, making sure to line up pin holes. Install pin, and rivet over ends to lock in place.

(5) **INSTALL LOWER BEARING** (fig. 121). Press bearing on shaft over splined end until it is tight against spider driver.

(6) **INSTALL ROCKER YOKE SHAFT AND BEARINGS** (fig. 121).

GOVERNOR

Install two snap rings on rocker yoke shaft. Insert shaft in body with long end toward throttle lever compartment. Install rocker yoke on shaft, and secure with two screws and lock washers. Press in both rocker yoke shaft bearings, using two tubes (1½-inch I.D. x 7/8-inch O.D. x 3 inches long) to help align bearings. Install oil seal with smooth side of the stamped case out. Be sure Neoprene packing is not turned over on the shaft. Install expansion plug in body.

(7) **INSTALL SPIDER SHAFT ASSEMBLY** (fig. 121). Insert spider shaft assembly into body, making sure the rocker yoke is located between upper bearing and upper bearing retainer. Install set screw in side of body, making sure its pilot point locates in groove in upper bearing retainer. Tighten set screw and lock nut securely.

(8) **INSTALL BASE** (fig. 121). Place new gasket on base, and bring base and body together. Install six screws and lock washers attaching base to body. Install washer and snap ring over splined end of spider shaft.

(9) **INSTALL THROTTLE LEVER** (fig. 121). Place throttle lever on rocker yoke shaft, and line up pin holes in lever and shaft. Install tapered pin. Install elbow and slotted plug in body.

(10) **INSTALL THROTTLE LEVER SPRING** (fig. 121). Hook spring onto vertical adjusting screw and horizontal adjusting screw. Insert horizontal adjusting screw with lock nut and lock washer through hole in body, and install drilled nut. See paragraph 81 c for adjustment of horizontal adjusting screw.

b. Dual Throttle Valve Box Assembly.

(1) **INSTALL BUTTERFLY SHAFTS** (fig. 123). Insert shafts through needle bearings in throttle valve housings. Install butterflies. This is done by dropping the butterflies in place, and tapping with a screwdriver until they are seated properly. Install two screws and lock washers attaching each butterfly.

(2) **INSTALL THROTTLE VALVE HOUSINGS** (fig. 123). Use new gaskets on throttle valve housings, and set them in place against ends of bell crank housing. Place bell cranks on ends of butterfly shafts in bell crank housing, but do not tighten them on shafts. Install four cap screws and lock washers attaching each throttle valve housing to bell crank housing.

(3) **INSTALL CONNECTING ROD AND BELL CRANKS** (fig. 123). Insert connecting rod through hole in bell crank housing. After lining up bell cranks, install screw, nut, and lock washer attaching bell cranks to connecting rod link. Turn bell cranks so that screw attaching bell cranks to rod link is away from connecting rod hole in body. Turn bell cranks until they are approximately 33 degrees from perpendicular with valves closed. Lock the bell cranks in position with cap screws and lock washers.

(4) **INSTALL CONNECTING ROD TUBE** (fig. 123). Install plain washers, felt washers, and spring on connecting rod tube in the order shown in figure 123. Place tube over connecting rod and into bell crank housing.

**ORDNANCE MAINTENANCE — ENGINE, ENGINE ACCESSORIES, CLUTCH GROUP,
AND PROPELLER SHAFT FOR 13-TON, HIGH-SPEED TRACTOR M5**

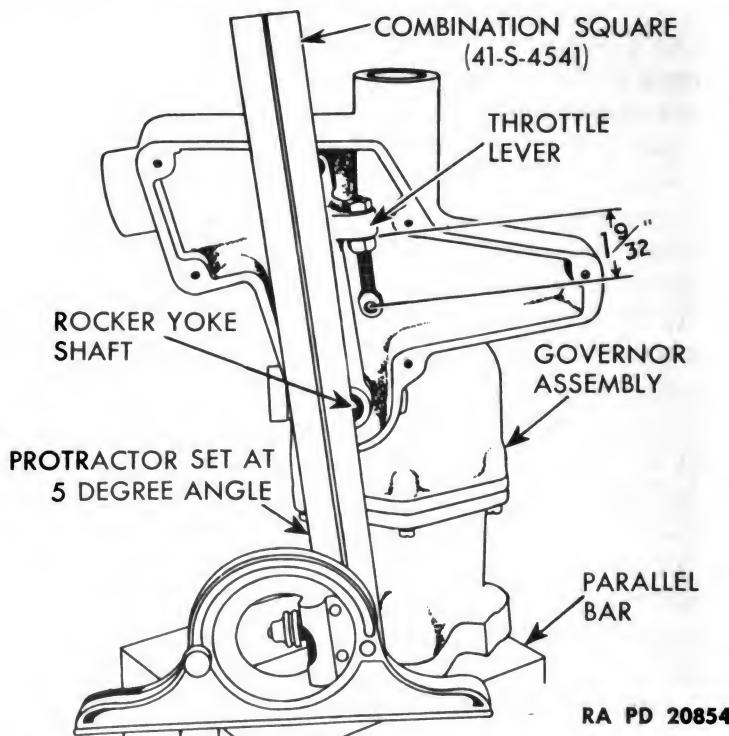


Figure 124 — Throttle Lever Positioned for Tapered Pin Hole

81. ADJUSTMENT.

a. **Vertical Adjusting Screw.** Turn two lock nuts on vertical adjusting screw until it measures $1\frac{9}{32}$ inches from the center of the eye hole in screw to the face on throttle lever (fig. 124). Tighten lock nuts securely when adjustment is correct. Also see subparagraph c following—

b. **Connecting Rod.** Refer to paragraph 39 x (3).

c. **Horizontal Adjusting Screw** (fig. 120 and 124). This adjustment is made with engine completely assembled ready for test. Cut and remove locking wire from screws attaching throttle lever cover. Remove six screws and lock washers, and lift off throttle lever compartment cover. Start engine and idle until engine coolant temperature reaches 160°F. Open engine throttle and note top speed. This should be 3,040 to 3,050 revolutions per minute with no load. To increase engine speed, turn drilled nut on horizontal adjusting screw clockwise, and to decrease engine speed turn nut counterclockwise. Tighten lock nut on horizontal adjusting screw inside of body when adjustment is correct. The vertical adjusting screw regulates the sensitivity of the governor. If governor surges, shorten the length of vertical adjusting screw to bring screw eye farther away from rocker yoke shaft. This broadens governor regulation. Increasing the length of vertical adjusting screw (by moving the spring eye closer to the rocker yoke shaft) increases the sensitivity of the governor.

CHAPTER 5

ENGINE LUBRICATING SYSTEM

	Paragraph
Description and data	82
Oil scavenger pump	83
Oil filters	84
Oil pump	85
Test and adjust engine lubrication system	86

82. DESCRIPTION AND DATA.

a. Description (fig. 125).

(1) ENGINE. The main oil pump is located in the oil pan. It is driven by the camshaft through helical gears. The oil is forced under pressure up through the oil pump body to passages drilled in the crankcase. The crankshaft bearings and the camshaft bushings are lubricated by pressure through drilled holes from the main header drilled through the full length of the crankcase. The connecting rod bearings are lubricated from the main bearings through passages drilled in the crankshaft checks. The piston pins and cylinder walls are lubricated by spray from spurt holes drilled in the lower ends of connecting rods. The rocker arms are lubricated from the front cam bearing through a passage drilled up through the crankcase and front cylinder head to the hollow valve rocker arm shaft. The timing gears are lubricated from the front cam bearing.

(2) SCAVENGER OIL PUMP. The scavenger oil pump is a double gear-type pump mounted on the left side of the crankcase. It is driven by the camshaft through helical gears. One set of gears in the pump draws the oil from one end of the oil pan; the other set of gears draws the oil from the other end of the oil pan. Both sets of gears discharge the oil into a common tube which empties into the center of the oil pan at the main oil pump.

(3) OIL COOLER. The oil cooler is enclosed in the oil filter and cooler base on the left side of the engine. The oil, after leaving the main pump, usually passes through the cooler on its way to the main header drilled in the crankcase. It lowers the temperature of the oil from 35° to 50° F. During cold weather when the oil is thick, or whenever the cooler becomes clogged, the oil is bypassed directly to the main header through a by-pass valve located in the right side of the crankcase.

(4) OIL FILTERS. The two standard military filters are mounted on the oil filter and cooler base. These filters are of the shunt type. Oil reaches the filters directly from the main oil gallery line, and flows freely back to the oil pan after passing through the filters.

(5) Replacement, removal and installation of scavenger oil pump, oil cooler, and oil filters are described in TM 9-786.

ORDNANCE MAINTENANCE — ENGINE, ENGINE ACCESSORIES, CLUTCH GROUP, AND PROPELLER SHAFT FOR 13-TON, HIGH-SPEED TRACTOR M5

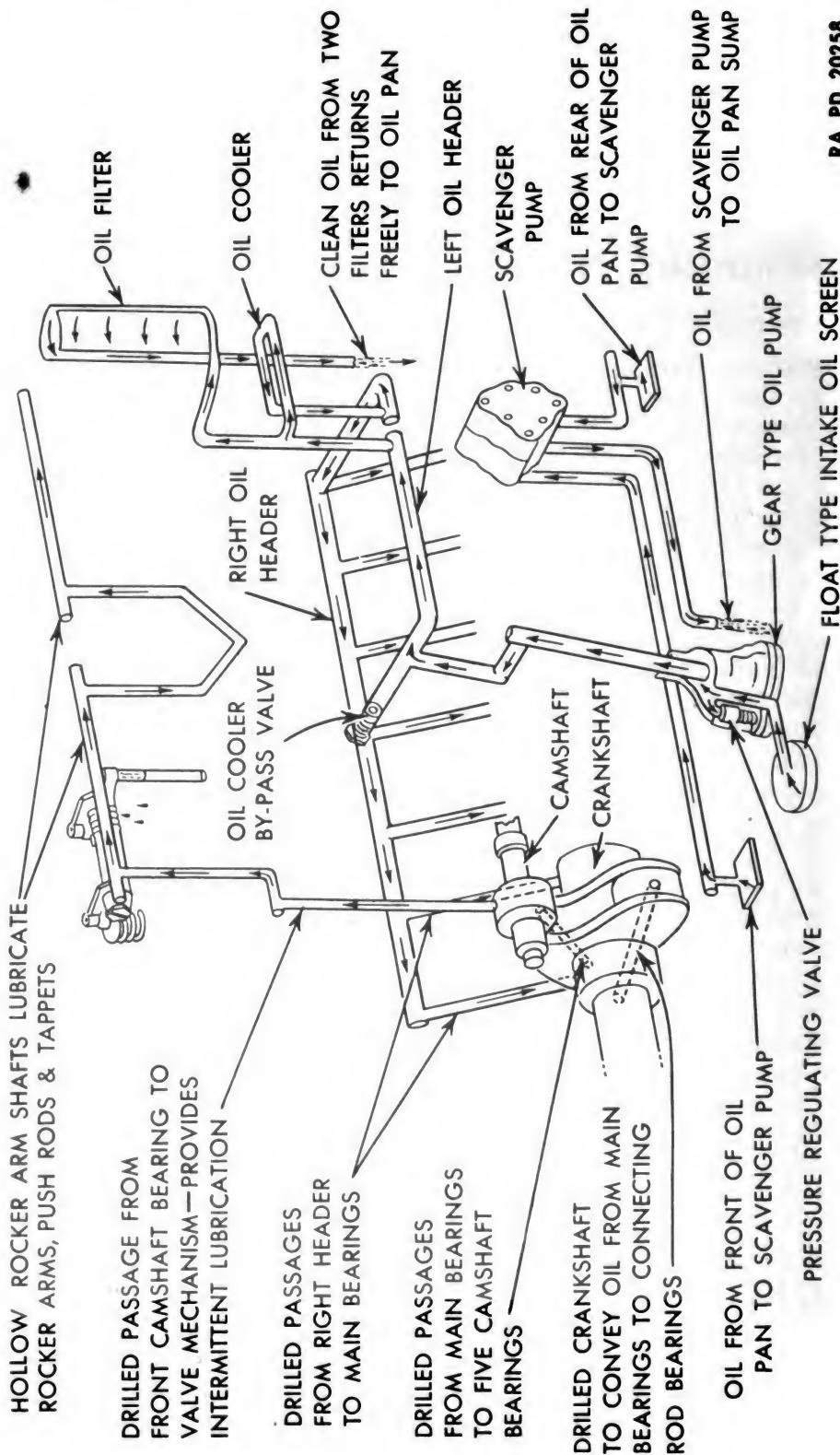


Figure 125 — Engine Lubrication Diagram

ENGINE LUBRICATING SYSTEM

b. Data.

(1) SCAVENGER OIL PUMP.

Make	Continental
Type	Gear
Drive	Helical Gear
Drive Shaft:	
O.D. of drive shaft	0.4985 to 0.4990 in.
I.D. of drive shaft bushings	0.5000 to .05010 in.
Clearance, shaft to bushing	0.0010 to 0.0025 in.
Drive Shaft:	
O.D. of driven shaft	0.5015 to 0.5020 in.
I.D. of driven gears	0.5035 to 0.5045 in.
Clearance, gears to shaft	0.0015 to 0.0030 in.
Pump Body:	
I.D. of gear bores	1.713 to 1.714 in.
O.D. of gears	1.707 to 1.709 in.
Clearance, gears to bores	0.004 to 0.007 in.

(2) OIL COOLER.

Make	Harrison
Model	HE-1050-700
Type	Plate

(3) OIL FILTERS.

Make	Purolator
Model	PD-50-02
Type	Military

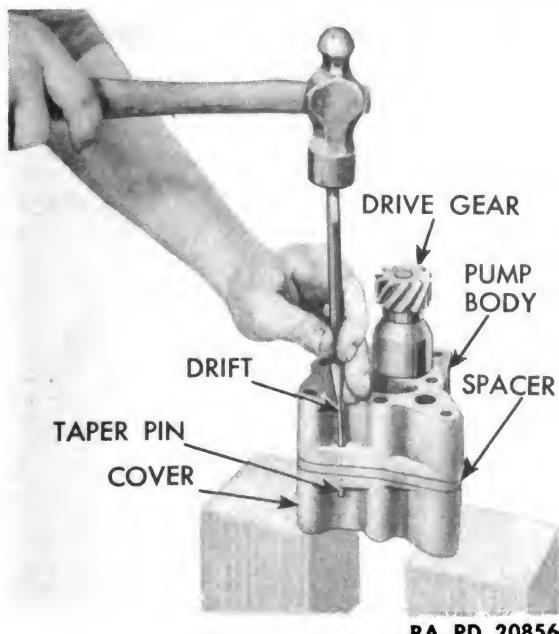


Figure 126 —

Removing
Scavenger Pump
Cover Taper Pin

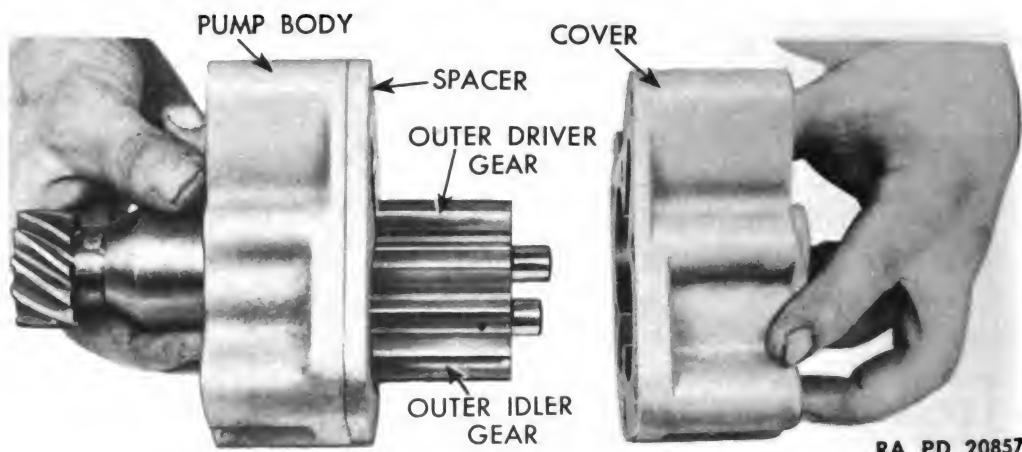
ORDNANCE MAINTENANCE — ENGINE, ENGINE ACCESSORIES, CLUTCH GROUP,
AND PROPELLER SHAFT FOR 13-TON, HIGH-SPEED TRACTOR M5

Figure 127 — Removing Scavenger Pump Cover

83. OIL SCAVENGER PUMP.

a. **Disassemble.** With a drift, drive out two taper pins holding pump body and cover together (fig. 126). Lift off scavenger oil pump cover (fig. 127). With a drift, drive out pin holding drive

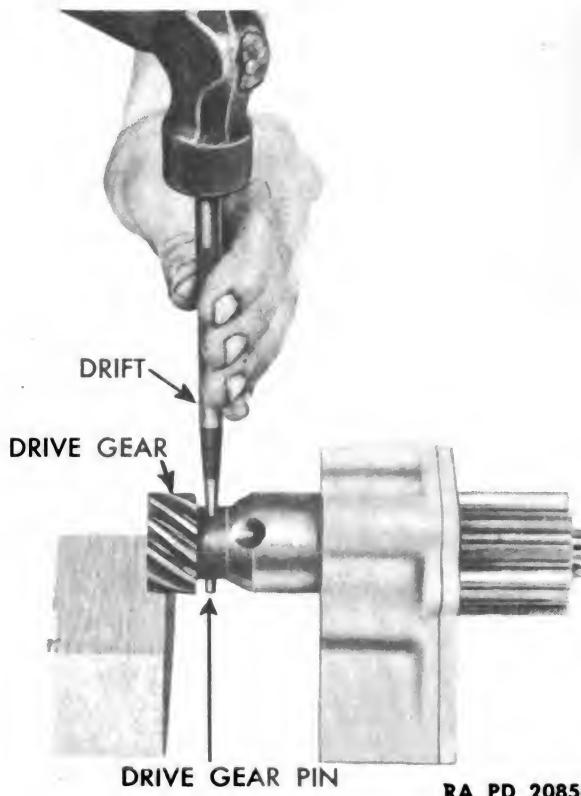


Figure 128 —
Removing
Scavenger Pump
Drive Gear Pin

ENGINE LUBRICATING SYSTEM

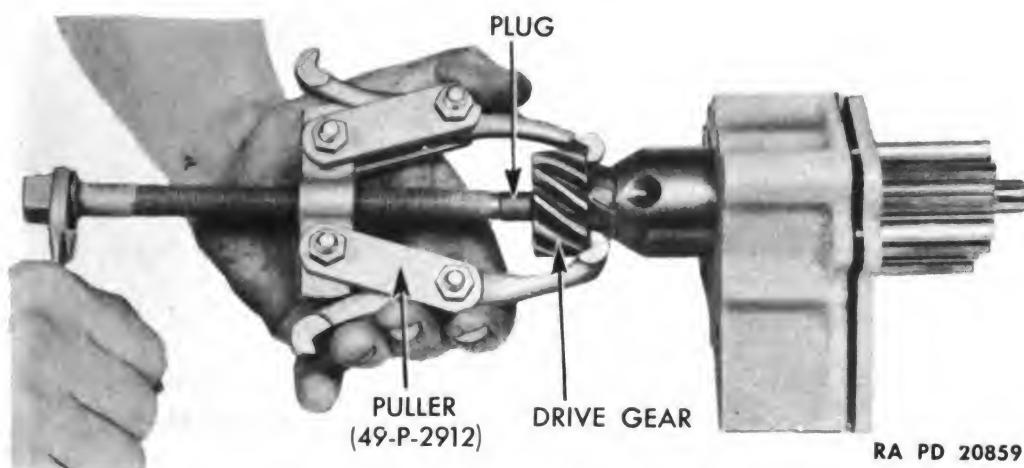


Figure 129 — Removing Scavenger Pump Drive Gear, Using Puller

gear to shaft (fig. 128). Remove drive gear from shaft with puller (41-P-2912) (fig. 129). Remove gear and shaft assembly from pump body. With a puller (41-P-2912), remove outer and inner driver gears from shaft (fig. 130). Supporting pump body on two wood blocks, drive out idler gear shaft (fig. 131). With a drift, knock out two expansion plugs from pump cover (fig. 132). Remove two Woodruff keys and snap ring from oil pump drive shaft.

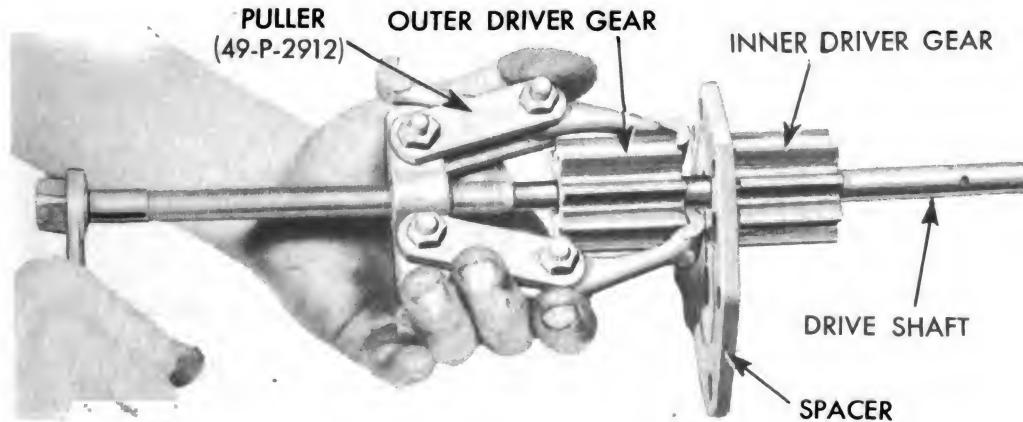


Figure 130 — Removing Scavenger Pump Outer Driver Gear, Using Puller

ORDNANCE MAINTENANCE — ENGINE, ENGINE ACCESSORIES, CLUTCH GROUP,
AND PROPELLER SHAFT FOR 13-TON, HIGH-SPEED TRACTOR M5

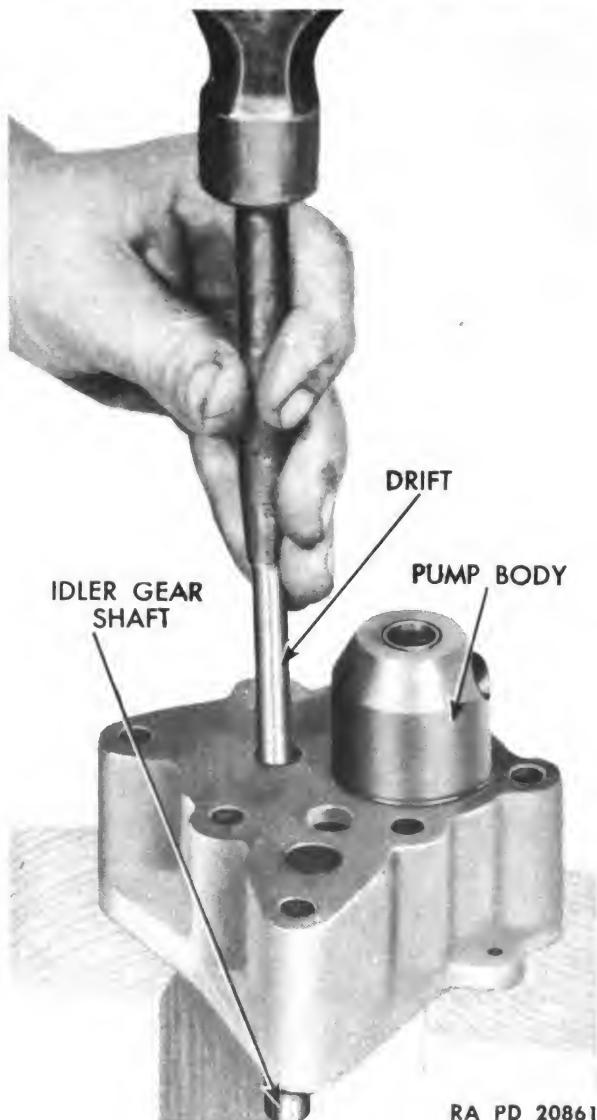


Figure 131 —

Removing
Scavenger Pump
Idler Gear Shaft

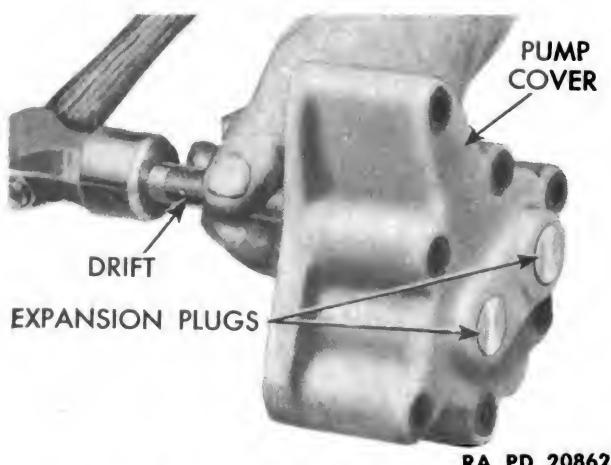


Figure 132 —

Removing
Expansion Plug
from Scavenger
Pump Cover

ENGINE LUBRICATING SYSTEM

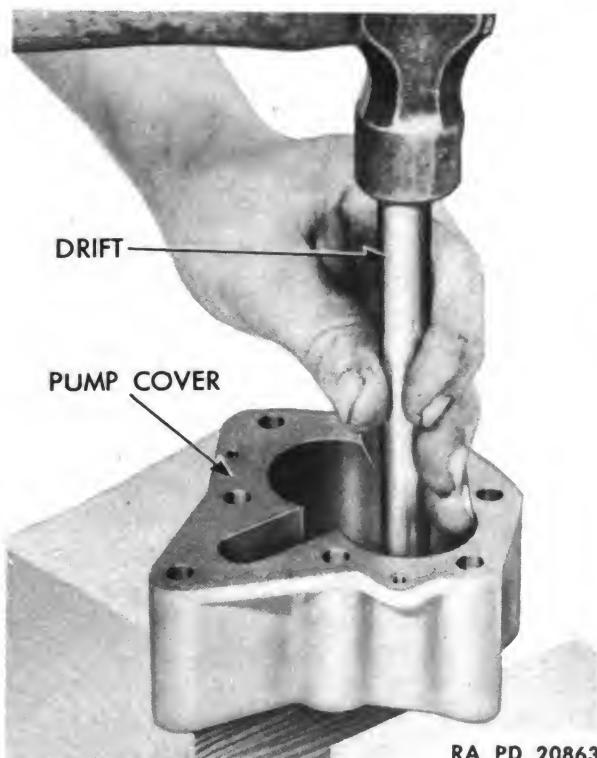


Figure 133 —
Removing Bushing
from Scavenger
Pump Cover

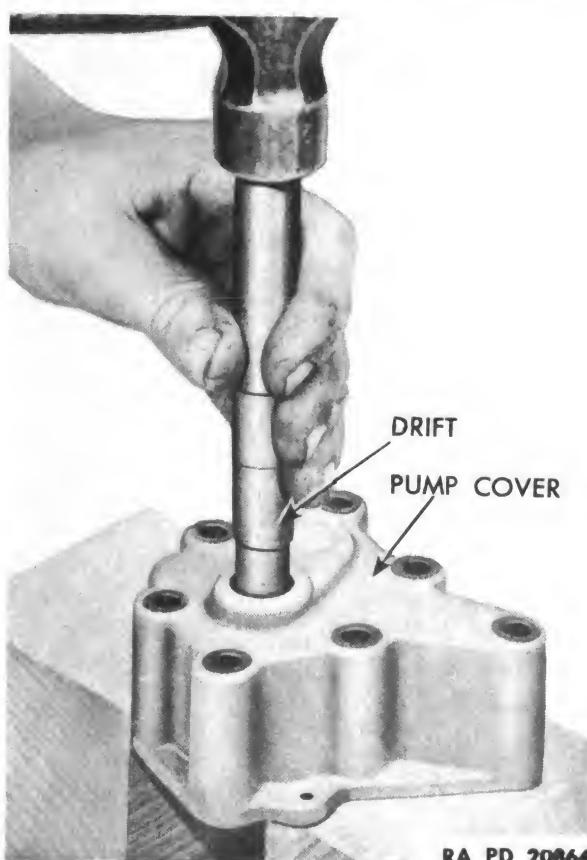


Figure 134 —
Installing Bushing
in Scavenger
Pump Cover

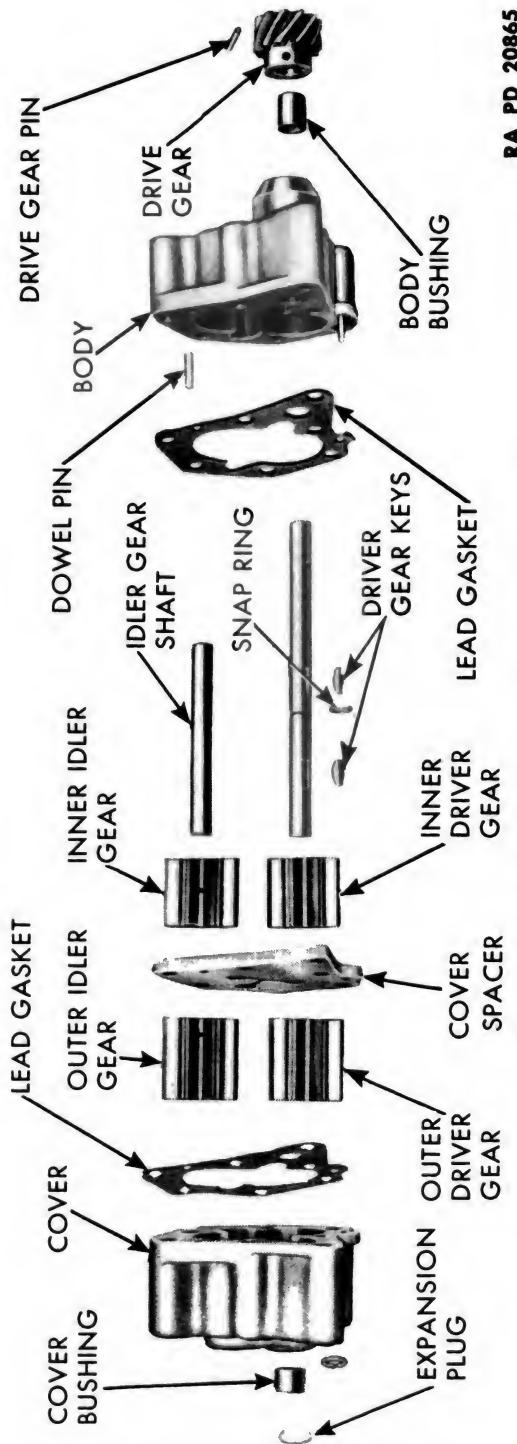
ORDNANCE MAINTENANCE — ENGINE, ENGINE ACCESSORIES, CLUTCH GROUP,
AND PROPELLER SHAFT FOR 13-TON, HIGH-SPEED TRACTOR M5

Figure 135 — Scavenger Oil Pump Components

ENGINE LUBRICATING SYSTEM

- b. **Clean.** Wash all parts with dry-cleaning solvent.
- c. **Inspect.** Examine pump body and cover surfaces for cracks. Replace cover and body if cracked. With a plug gage, check gear bores in both body and cover. Bores in new parts measure 1.713 to 1.714 inches. With a plug gage, measure drive shaft bushings in both body and cover. New bushings measure 0.500 to 0.501 inch. Refer to subparagraph d for replacing worn bushings. Check inside diameter of inner and outer idler gears. New gears measure 0.5035 to 0.5045 inch. Replace worn gears. Measure diameter of drive shaft. New shaft measures 0.4985 to 0.4990 inch. Replace worn shaft. Measure diameter of idler shaft. New shaft measures 0.5015 to 0.5020 inch. Replace worn shaft. Examine teeth of all gears, and replace gears with worn or damaged teeth.
- d. **Repair.** With a $19\frac{1}{32}$ -inch diameter drift, drive bushing out of oil pump cover (fig. 133). With same drift, drive new bushing in (fig. 134). Perform same operations on oil pump body, except that two bushings are used. Drive one bushing in from outside, and one in from gear bore side of body. Place scavenger pump spacer between body and cover, and bolt body and cover together with seven $5\frac{1}{16}$ -inch bolts and nuts. Do not tighten nuts. Drive two taper pins in holes in body and cover flanges. Tighten seven nuts. Line-ream bushings in cover and body 0.500 to 0.501 inch. Drive taper pins out (fig. 126), and remove bolts.
- e. **Assemble** (fig. 135). Cover inside face and edges of two expansion plugs with sealing compound, and install them in oil pump cover. Insert snap ring in groove on drive shaft. Install one Woodruff key in keyway for inner driver gear. Press inner driver gear on drive shaft from inner end of shaft with counterbore of gear over snap ring. Be sure gear is snug against snap ring. Install shaft and gear in pump body, and press drive gear on. Install drive gear pin, and rivet both ends of pin. One end of idler shaft has a very short taper. Press this tapered end into pump body until tapered end of shaft is flush with crankcase contact face of pump. Assemble inner idler gear (shorter of the two idler gears) onto idler gear shaft, and insert into pump body. Place a new lead gasket on gear chamber side of pump body, and install cover spacer. Install second drive gear key in drive shaft, and press outer driver gear on. Press gear on until close to spacer, but not tight enough to cause shaft to bind. Install outer idler gear on idler gear shaft. Place lead gasket on spacer, and install oil pump cover. Drive two taper pins in holes in flanges of body and cover. Bolt pump assembly together with seven $5\frac{1}{16}$ -inch bolts and nuts, to assure pump remaining in good condition until assembled to engine.

84. OIL FILTERS.

- a. **Disassemble.** Refer to TM 9-786.
- b. **Clean and Inspect.** Wash all parts except elements in dry-cleaning solvent. Replace elements. Inspect threads on

**ORDNANCE MAINTENANCE — ENGINE, ENGINE ACCESSORIES, CLUTCH GROUP,
AND PROPELLER SHAFT FOR 13-TON, HIGH-SPEED TRACTOR M5**

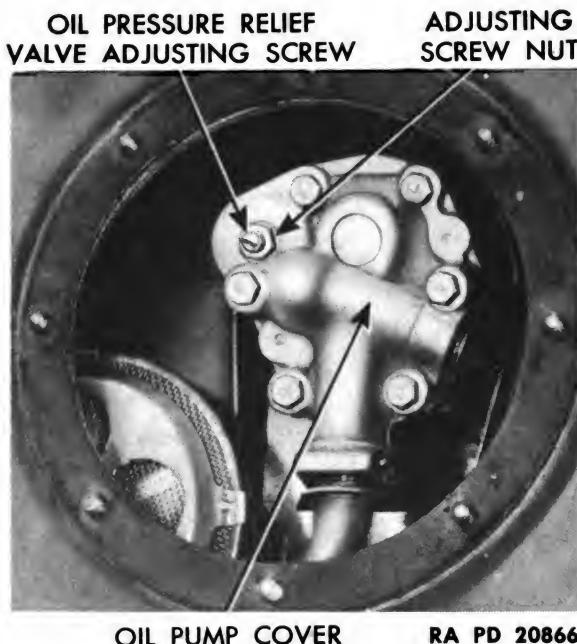


Figure 136 —

**Oil Pressure
Relief Valve
Adjusting Screw**

retaining nuts, retaining bars, and cover screws. Replace parts with defective threads. Examine filter cases for damage, particularly top and bottom edges that contact gaskets. Replace damaged cases. Examine covers for damage due to retaining nuts being excessively tightened. Replace sprung covers

c. Assemble. Refer to TM 9-786.

85. OIL PUMP.

a. Disassembly, cleaning, inspecting, and assembling of oil pump are described in paragraph 35.

86. TEST AND ADJUST ENGINE LUBRICATION SYSTEM.

a. Test. Start the engine and operate it at a moderate speed until coolant temperature reaches approximately 160° F. When this temperature is reached, increase engine speed to 2,500 revolutions per minute. At this speed with hot oil, the oil pressure should be 50 to 55 pounds. If the pressure is above or below 50 to 55 pounds, adjust pressure as explained in subparagraph b below.

b. Adjust. Remove bottom plate from below engine. Drain engine oil. Remove oil pan handhole cover (fig. 57). Loosen adjusting screw nut on oil pressure regulating screw (fig. 136). To increase oil pressure, turn oil pressure relief valve adjusting screw clockwise. To decrease pressure, turn screw counterclockwise. One complete turn of adjusting screw changes pressure approximately 8 pounds. After adjustment is made, tighten lock nut. Replace handhole cover, and fill engine with oil. Test oil pressure (subpar. a above). Replace bottom plate.

CHAPTER 6

IGNITION SYSTEM

Paragraph

Description and data	87
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87. DESCRIPTION AND DATA.

a. **Description.** Ignition is provided by a single-ignition distributor mounted on the left side of the engine. It is driven through a tongue and groove coupling from the governor shaft. The distributor is connected to the six spark plugs on the left side of the cylinder head. The battery voltage is stepped up by the 12-volt ignition coil mounted on the coolant inlet header on the left side of the cylinder head.

b. For information on distributor and ignition coil, refer to TM 9-1825A covering electrical equipment.

c. Removal and installation of distributor and ignition coil, and data on ignition timing, are described in TM 9-786.

d. Data.

(1) DISTRIBUTOR.

Make	Delco-Remy
Model	1110170
Rotation (from top)	Counterclockwise

(2) IGNITION COIL.

Make	Delco-Remy
Model	1115253
Voltage	12 volts

(3) SPARK PLUGS.

Make	Champion
Type	5 commercial
Size (thread)	18 mm.

ORDNANCE MAINTENANCE — ENGINE, ENGINE ACCESSORIES, CLUTCH GROUP,
AND PROPELLER SHAFT FOR 13-TON, HIGH-SPEED TRACTOR M5

CHAPTER 7

CLUTCH GROUP AND PROPELLER SHAFT

Section I

DESCRIPTION

Paragraph

Description	88
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88. DESCRIPTION.

a. The clutch group includes the engine clutch, clutch controls, and clutch reduction unit. The engine clutch and clutch reduction unit combined are that part of the power train which transmits power from the engine to the transmission through the propeller shaft. The clutch serves its usual function of disengaging the engine power from the power train. In addition it provides a means of allowing the engine to run at a sufficiently high speed to develop enough power for starting the vehicle, applying this power to the tracks without jerks and without stalling the engine. The clutch, together with the clutch reduction unit and clutch selector, has an additional function. It is possible for the operator to shift to a higher or to a lower range, equivalent to approximately one gear ration in the transmission, by merely pushing the service clutch pedal to the toeboard, and releasing it again to engage the clutch. This shift can be made in all transmission speeds. This feature permits quick shifting to a more effective speed range on hills, or in ordinary service, without using the transmission shifting lever. The clutch has two driven plates. One plate transmits engine power directly through the clutch and propeller shaft to the transmission (fig. 137). The second plate transmits engine power through the reduction unit gears and propeller shaft to the transmission (fig. 138). The clutch reduction unit, in combination with the four-speed transmission, gives the vehicle five forward speeds and two reverse speeds. NOTE: *There are not more speeds because the clutch reduction unit gear ration is approximately the same as the gear ratio between each set of gears in the transmission. For example, high-range first speed is approximately the same as low-range second, and high-range second is approximately the same as low-range third.* Refer to TM 9-786 for the speeds in each gear and in each range.

b. The clutch is controlled by a conventional clutch pedal, designated as the service clutch pedal. In normal operation the clutch is operated by air pressure through a shifting valve and two power cylinders. This makes it possible for the operator to engage or disengage the clutch, or to change from low to high range at any speed of the vehicle with very little effort. An emergency clutch pedal, located beside the service clutch pedal, will operate the clutch should the air system fail.

DESCRIPTION

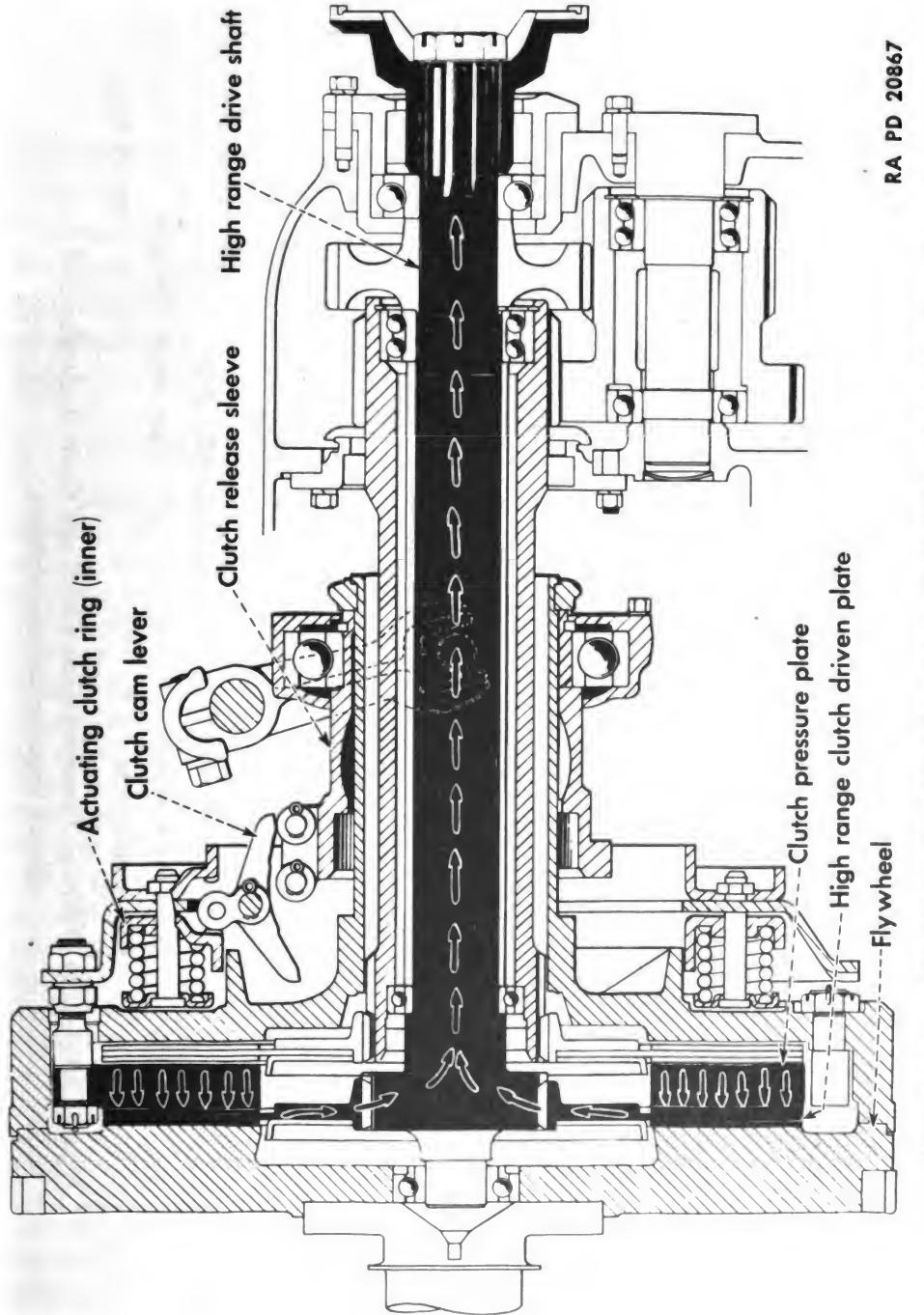
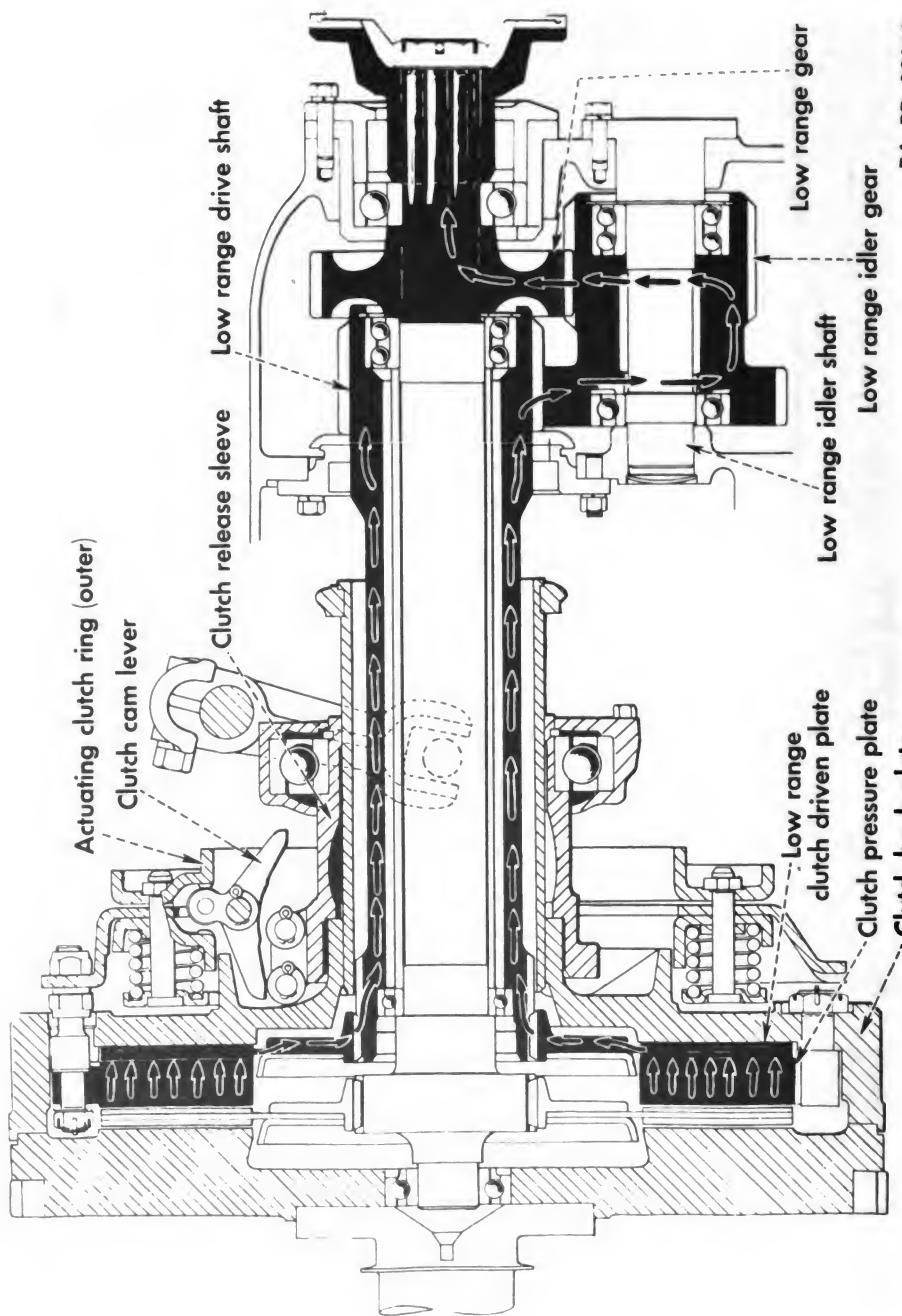


Figure 137 — Line of Power Through Engine Clutch and Gear Reduction Unit — Clutch Engaged in High Range

**ORDNANCE MAINTENANCE — ENGINE, ENGINE ACCESSORIES, CLUTCH GROUP,
AND PROPELLER SHAFT FOR 13-TON, HIGH-SPEED TRACTOR M5**



**Figure 138 — Line of Power Through Engine Clutch and Gear Reduction Unit —
Clutch Engaged in Low Range**

CHAPTER 7 (Cont'd)**CLUTCH GROUP AND PROPELLER SHAFT
(Cont'd)****Section II****ENGINE CLUTCH**

	Paragraph
Description, operation, and data	89
Removal	90
Disassembly	91
Cleaning, inspection, and repair	92
Assembly	93
Installation	94
Tests	95

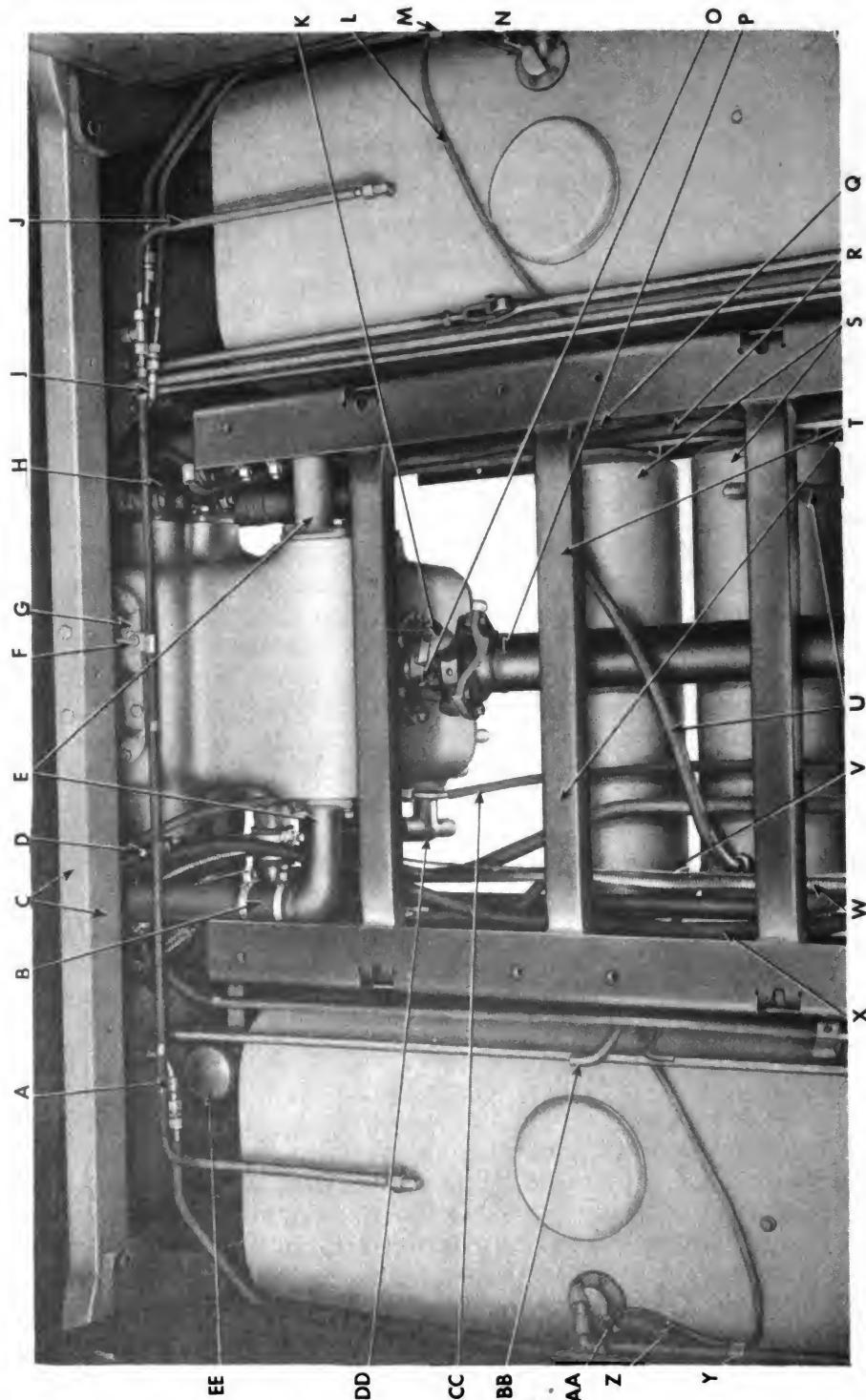
89. DESCRIPTION, OPERATION AND DATA.

a. Description. The Atwood two-way constant pressure clutch consists of two clutches combined into one self-contained unit in such a manner that either one can be engaged while the other remains disengaged, or both can be held in a disengaged position. The clutch is composed of a back plate, pressure plate, spring retainer unit, actuating mechanism consisting of four cam levers, release sleeve unit, and two driven plates. The clutch is bolted to the engine flywheel which provides one of the driving surfaces for one of the driven plates. The release sleeve is mounted on a quill which extends from the back plate. The sleeve can be set in one of three positions: toward the engine flywheel, in neutral or central position, and away from the flywheel.

b. Operation. As used in the 13-ton, high-speed tractor M5, the driven plate, which is engaged by the engine flywheel and pressure plate, drives the propeller shaft at the same speed as the engine flywheel (fig. 137). The other driven plate, which is engaged by the clutch back plate and pressure plate, drives the propeller shaft through a clutch gear reduction unit at a lower speed than the engine flywheel (fig. 138). The engine clutch is engaged by air pressure through a conventional clutch pedal. By pushing the clutch pedal past the neutral position down to the toeboard, the clutch pressure plate is shifted from one driven plate to the other driven plate. This feature permits quick shifting from high range to low range, and is equivalent to approximately one full gear ratio in the transmission. The clutch may be operated manually through a separate emergency pedal, in case the air pressure is insufficient to operate the clutch power cylinder.

c. Data.**(1) SPECIFICATIONS.**

Make Atwood

ORDNANCE MAINTENANCE — ENGINE, ENGINE ACCESSORIES, CLUTCH GROUP,
AND PROPELLER SHAFT FOR 13-TON, HIGH-SPEED TRACTOR M5

RA PD 20869

Figure 139 — Clutch Assembly with Shell Box Removed

ENGINE CLUTCH

A	CLIP	Q	LEFT CABLE HARNESS
B	HOSE	R	CLUTCH SHIFTER LEVER ROD
C	CROSS MEMBER	S	AIR TANKS
D	LUBRICATOR TUBE	T	SHELL BOX SUPPORT
E	COOLANT ELBOWS	U	AIR TUBES
F	TUBE CLIP	V	ENGINE HEAT INDICATOR CABLE
G	CLUTCH HOUSING COVER	W	TACHOMETER CABLE
H	CLUTCH SHIFTER LEVER	X	RIGHT CABLE HARNESS
I	CLIP	Y	CLIP
J	FUEL TANK VENT TUBE	Z	FUEL GAGE CABLE
K	TRUNNION BEARING	AA	TERMINAL
L	FUEL GAGE CABLE	BB	AIR TANK DRAIN CONTROL ROD
M	CLIP	CC	CLUTCH BREATHER TUBE
N	TERMINAL	DD	COOLANT DRAIN VALVE
O	UNIVERSAL JOINT FITTING YOKE	EE	OIL FILLER
P	PROPELLER SHAFT		

RA PD 20869a

Legend for Figure 139 — Clutch Assembly with Shell Box Removed

**ORDNANCE MAINTENANCE — ENGINE, ENGINE ACCESSORIES, CLUTCH GROUP,
AND PROPELLER SHAFT FOR 13-TON, HIGH-SPEED TRACTOR M5**

Model	TA16-4
Type	Two-way constant pressure
Weight	265 lb
Clutch serial number	1,000 up
Serial number location	Outer circumference of backplate

(2) DRIVEN PLATE.

Number of plates	2
Facing O.D.	15 $\frac{7}{8}$ in.
Facing I.D.	9 in.
Thickness of disk facing	0.340 to 0.345 in.
Facing area	134 sq in.
Distance from stop clamp to release sleeve-neutral position	1.200 in.
Plate clearance in neutral position	0.040 in.
Weight of driven plate	14 lb.

(3) PRESSURE SPRINGS.

Number of springs	12
Free length of spring	2 $\frac{31}{64}$ in.
Test load at 1 $\frac{13}{16}$ -inch length	273 to 301 lb

(4) EQUALIZER SPRINGS.

Number of springs	6
Free length of spring	1 $\frac{1}{8}$ in.
Test load at 1 $\frac{5}{16}$ -inch length	36 to 44 lb

90. REMOVAL.

a. The engine clutch with clutch gear-reduction unit is usually removed with the engine as an assembly. When the clutch has been removed with engine assembly according to TM 9-786, follow procedure below beginning with step (18). If it is necessary to remove the clutch only from the vehicle, without removing the engine, proceed as follows:

- (1) **REMOVE FRONT CENTER BOTTOM PLATE.** Remove 25 cap screws and lock washers attaching bottom plate.
- (2) **REMOVE CENTER BOTTOM PLATE, CENTER.** Remove 18 cap screws and lock washers attaching bottom plate.
- (3) **REMOVE SHELL Box.** Refer to TM 9-786.
- (4) **DISCONNECT TRANSMISSION OIL FILTER CONTROL ROD.** Remove cotter pin and washer connecting control rod to ratchet handle on top of filter.
- (5) **DISCONNECT AIR TANK DRAIN COCK CONTROL ROD (fig. 139).** Remove cotter pin and pin attaching drain cock control rod to cross rod lever between air tanks.

ENGINE CLUTCH

(6) **DRAIN COOLANT.** Open coolant drain valve controlled by handle located in right-front corner of engine compartment.

(7) **REMOVE COOLANT DRAIN VALVE.** Remove cotter pin connecting drain valve rod to drain valve (fig. 139) at bottom of clutch gear-reduction unit. Remove two cap screws and lock washers attaching drain valve to gear compartment cover.

(8) **REMOVE CLUTCH GEAR-REDUCTION UNIT OIL FILLER TUBE** (fig. 139). Remove two cap screws and lock washers attaching oil filler to shell box support. Loosen two hose clamps attaching hose to filler tube and nipple. Remove filler tube and hose.

(9) **DISCONNECT ELECTRIC CABLES** (fig. 139). Remove nut and lock washer attaching right fuel tank gage cable to terminal, and remove cable from clip on fuel tube and out through shell box support opening. Remove right cable harness from three clips under shell box support. Remove nut and washer attaching left fuel tank gage cable to terminal, and remove wire from clip on fuel tube and out through shell box support opening. Remove left cable harness from five cable clips on shell box support.

(10) **REMOVE CLUTCH HOUSING COOLANT ELBOWS** (fig. 139). Remove two screws and lock washers attaching left elbow to housing. Loosen hose clamp attaching hose to coolant pipe, and remove elbow with hose from housing and coolant pipe. Remove two cap screws attaching right elbow to clutch housing, and loosen hose clamp attaching hose to coolant pipe. Remove right elbow with hose from housing and coolant pipe.

(11) **REMOVE SHELL Box SUPPORT** (fig. 139). Remove eight cap screws and lock washers attaching support to frame channels. Remove support by first raising front end of shell box support, and then slipping it from end of coolant return pipe at left-rear corner.

(12) **REMOVE VENT TUBE FROM RIGHT FUEL TANK TO TEE** (fig. 139). Disconnect vent tube from right fuel tank elbow fitting and tee fitting. Remove two cap screws and lock washers attaching two clips to clutch housing cover. Remove vent tube from two clips attaching it to the other tubes.

(13) **DISCONNECT CLUTCH HOUSING BREATHER TUBE** (fig. 139). Disconnect tube from tee at front of clutch housing, and move tube aside.

(14) **DISCONNECT CLUTCH RELEASE YOKE BEARING LUBRICATOR TUBE** (fig. 139). Disconnect tube from elbow fitting on clutch shifting shaft cover at right side of housing.

(15) **REMOVE PROPELLER SHAFT** (fig. 139). Remove four cap screws and two lock plates attaching two universal joint trunnion bearings to universal joint fitting yoke. Remove propeller shaft by sliding brake drum off splined transmission input shaft. Tie trunnion bearings in place on spider with wire to prevent loss.

(16) **DISCONNECT CLUTCH SHIFTING ROD** (fig. 139). Remove cotter pin and pin attaching rod to shifting lever. Move rod to one side.

(17) **REMOVE AIR RESERVOIR TANKS** (fig. 139). Disconnect

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air tube leading from compressor to air tank at connector on top of rear air tank. Disconnect air tank to air tank tube at connectors, and remove tube. Disconnect air tank to air separator tube at air tank fitting and at union, and remove tube. Remove eight cap screws with lock washers attaching two air tanks to main frame channel. Remove air tanks with cross rod lever.

(18) REMOVE CLUTCH HOUSING COVER (fig. 139). Remove eight cap screws and lock washers attaching clutch housing cover to housing. Remove two cap screws, nuts, and lock washers attaching cover to cross member.

(19) DISCONNECT CLUTCH FROM FLYWHEEL. Remove nine nuts and lock washers from studs attaching clutch to flywheel. Reach inside clutch housing, and rotate flywheel with engine hand crank to gain access to all nine nuts.

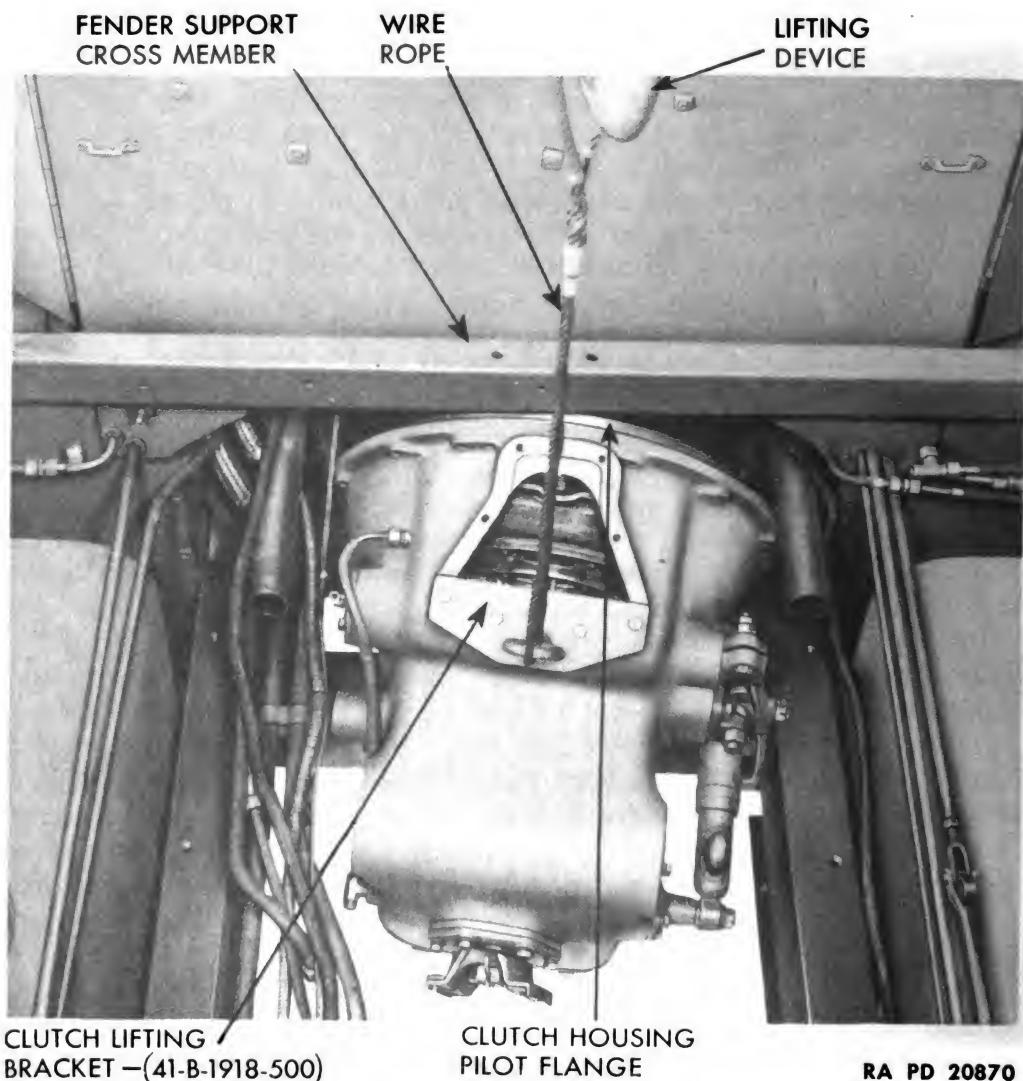
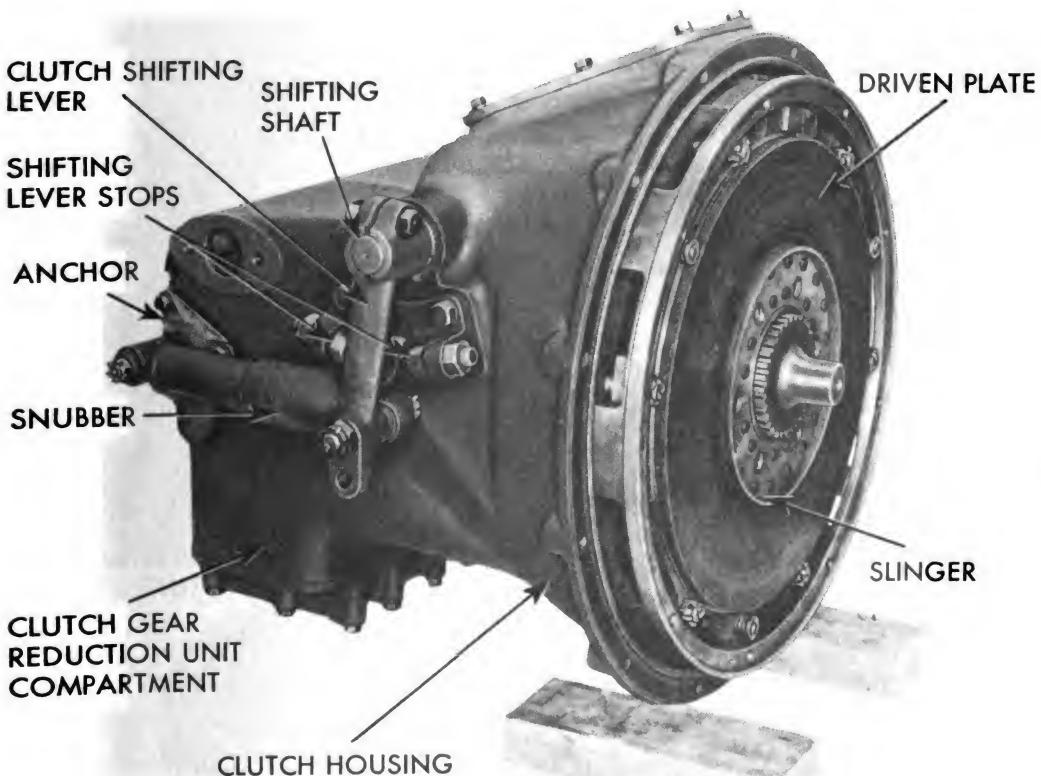


Figure 140 — Removing Clutch Assembly, Using Lifting Bracket

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(20) **INSTALL LIFTING FIXTURE** (fig. 140). Attach clutch lifting bracket (41-B-1918-500) to clutch housing with four cap screws and lock washers. Using a lifting device and wire rope, lift clutch reduction unit high enough to take load off engine flywheel housing.

(21) **REMOVE CLUTCH AND CLUTCH GEAR REDUCTION UNIT ASSEMBLY** (fig. 140). Remove 12 cap screws and lock washers attaching clutch housing to flywheel housing. Slide unit straight out from flywheel housing. Be sure clutch does not bind on flywheel studs, and that it comes out with clutch housing assembly. The high-range drive shaft is pulled from clutch pilot bearing in engine flywheel as the clutch and clutch gear-reduction unit are being removed. When the unit is free from flywheel and flywheel housing, tip front of unit down so that top pilot flange will clear rear fender support cross member, and bottom of flange will slide over frame cross member. Lift clutch and clutch gear-reduction unit assembly up and out of vehicle.



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Figure 141 — Clutch and Clutch Gear Reduction Unit Assembly

(22) **REMOVE CLUTCH SHIFTING LEVER** (fig. 141). Remove nut and cotter pin attaching snubber to anchor. Remove cap screw, nut, and lock washer attaching shifting lever to clutch shifting shaft. Slide lever from shaft, and at the same time remove snubber from anchor. Remove Woodruff key from shaft.

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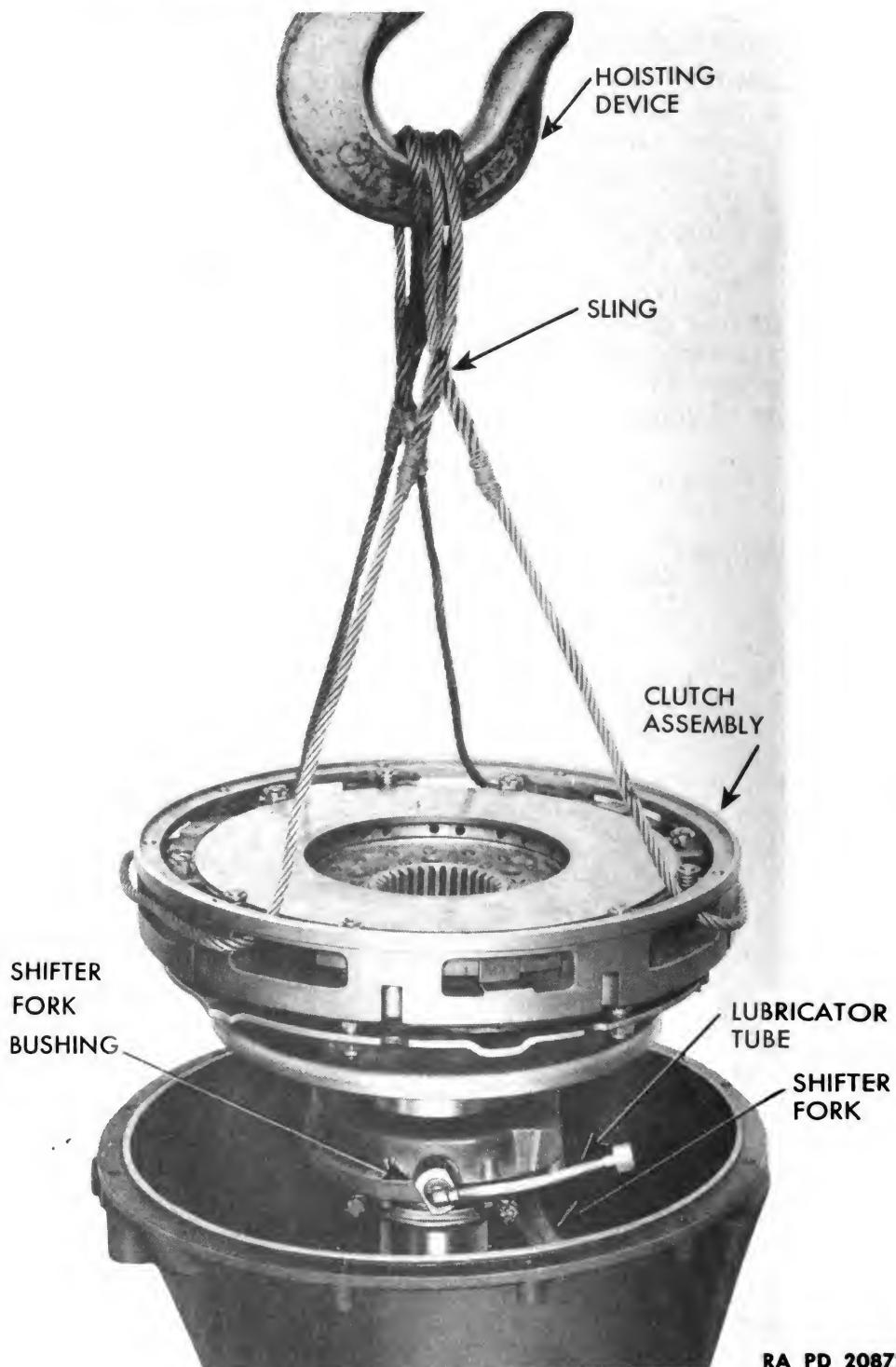


Figure 142 — Removing Clutch from Clutch Housing

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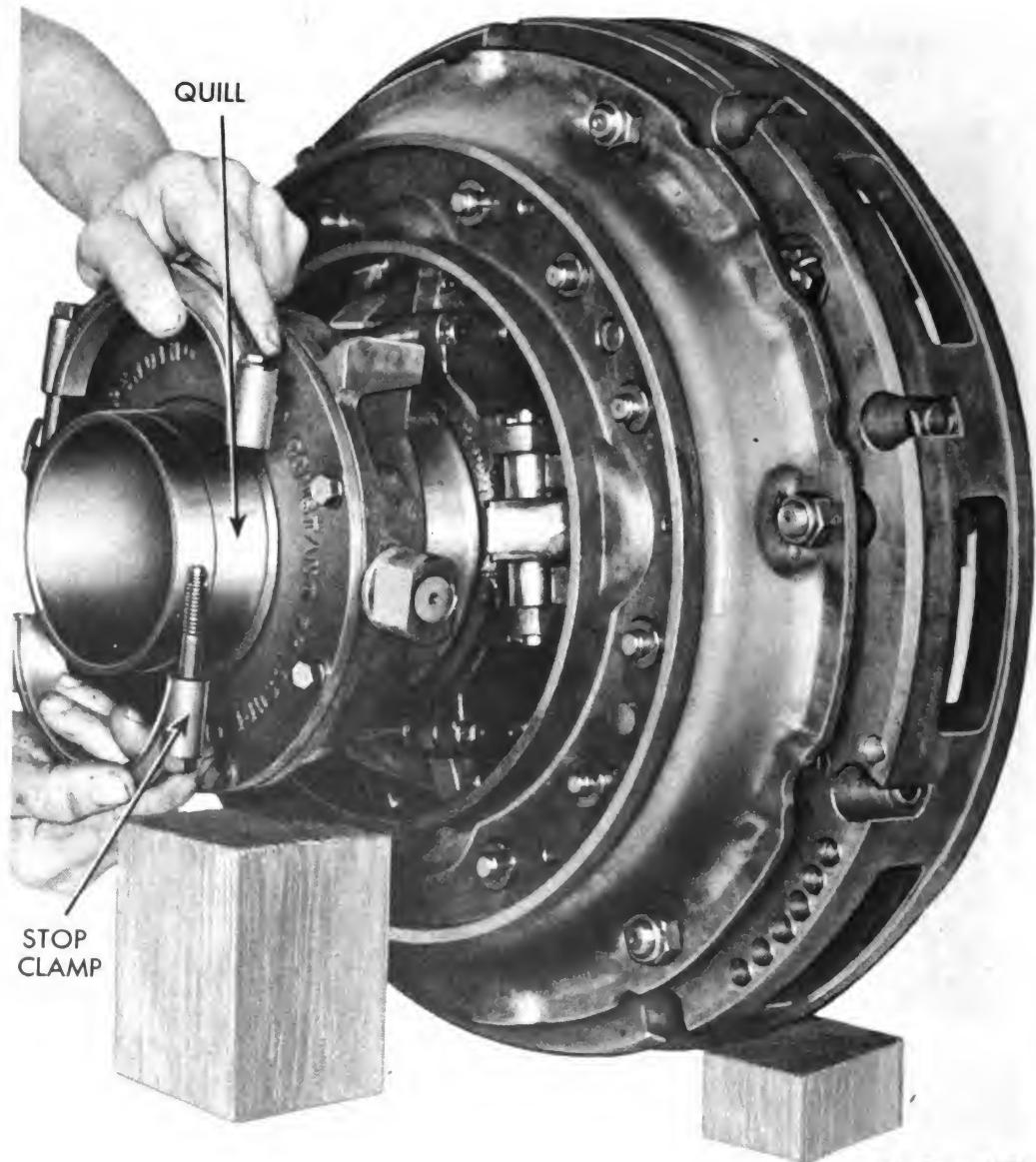


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Figure 143 — Clutch Release Bearing Lubricator Tube

(23) REMOVE CLUTCH FROM CLUTCH HOUSING. Set clutch reduction unit on its front end, and block it securely to prevent unit from tipping. Using a wire rope sling and hoising device (fig. 142), partially lift clutch assembly out of housing so that clutch release bearing lubricator tube (fig. 143) can be disconnected from fitting in shifting lever shaft. Line up splines on low-range drive shaft with those on high-range drive shaft, and lift clutch assembly from housing.

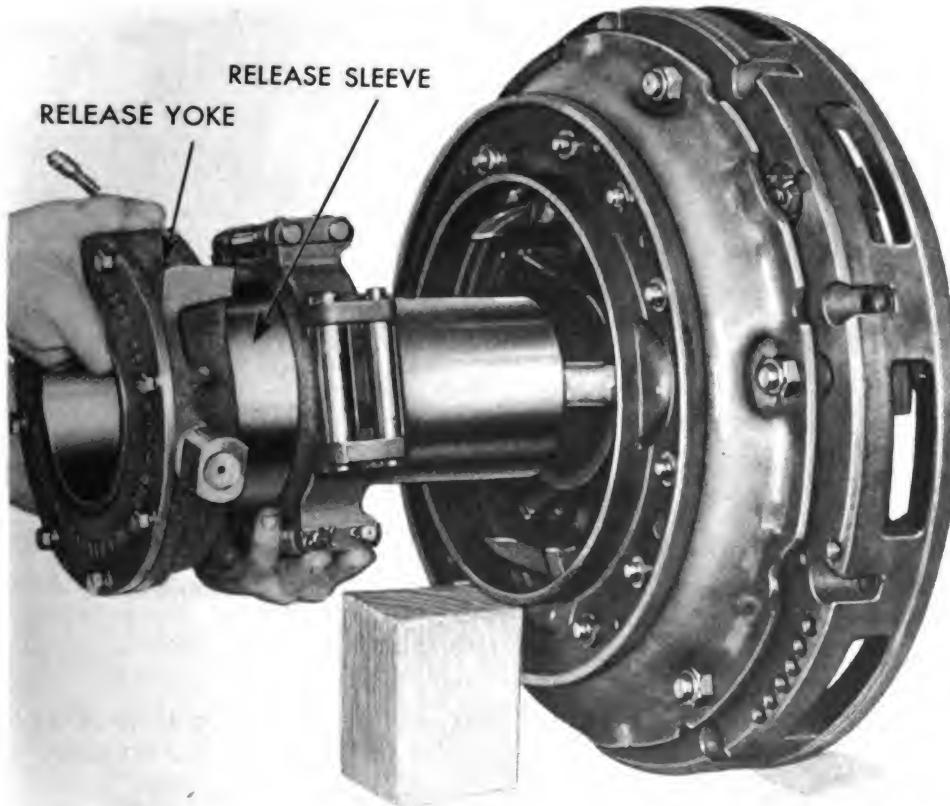
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Figure 144 — Removing Clutch Release Sleeve Stop Clamp

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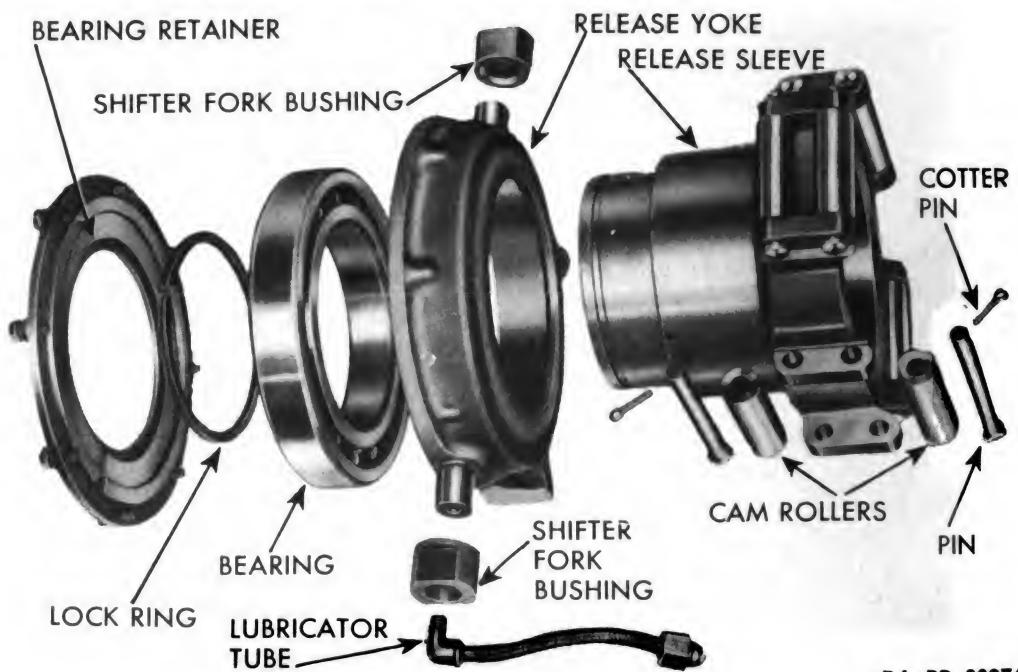
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Figure 145 — Removing Clutch Release Sleeve Assembly

91. DISASSEMBLY.

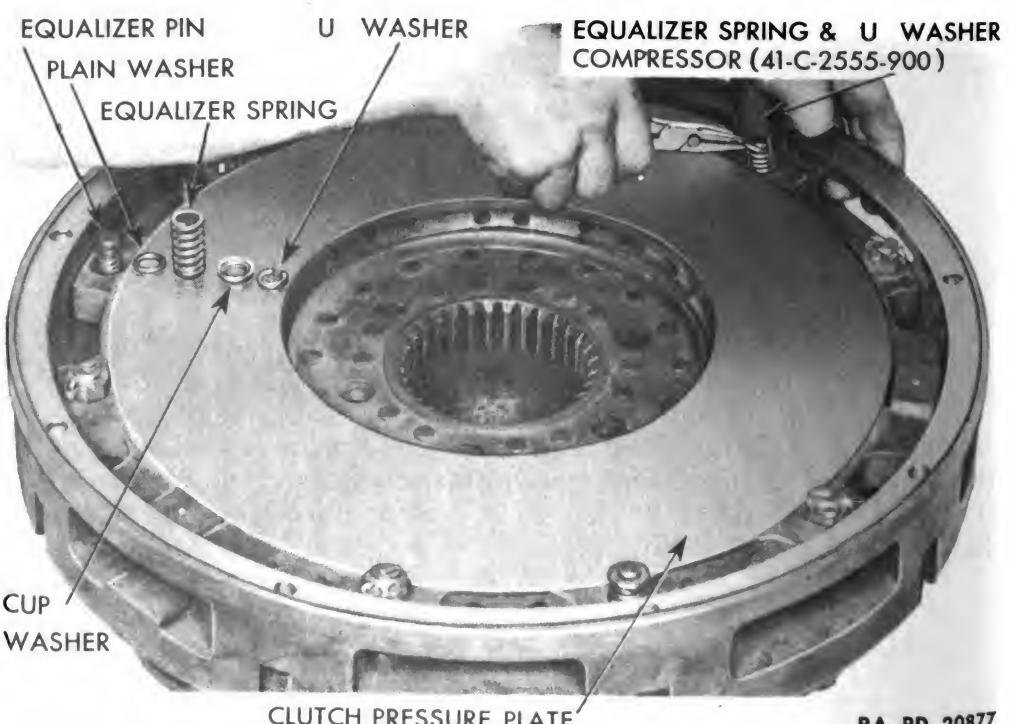
- a. **Remove Clutch Release Yoke and Sleeve Assembly.** Remove two cotter pins, nuts, and bolts securing stop clamps to welded quill in clutch backplate (fig. 144). Slide clutch release sleeve and yoke off quill (fig. 145).

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Figure 146 — Clutch Release Sleeve Assembly Components



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Figure 147 — Removing Clutch Pressure Plate Equalizer Spring, Using Clutch Equalizer Spring and U-Washer Compressor to Remove U-Washer and Spring

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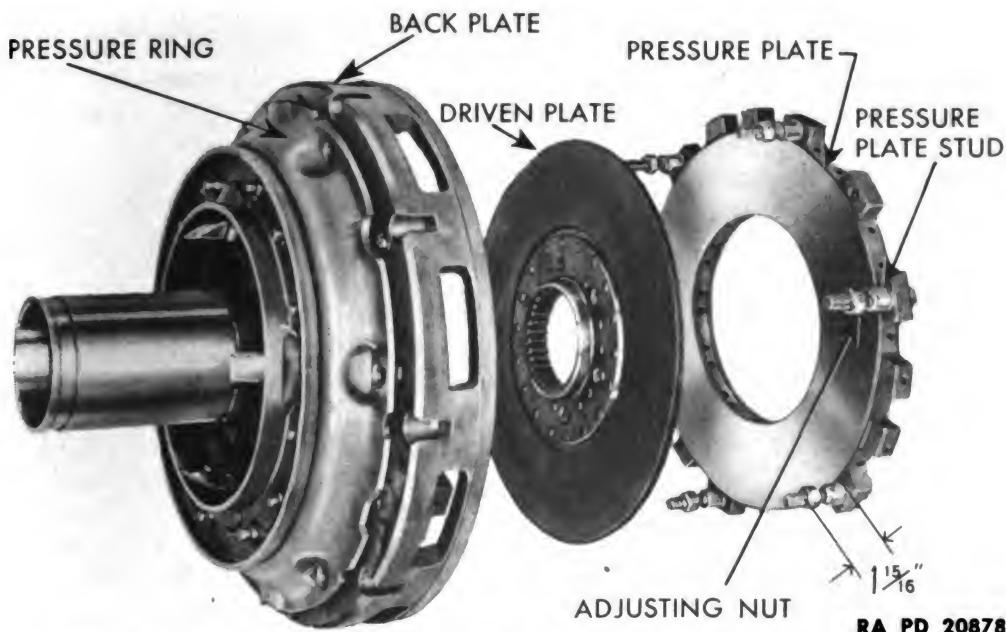


Figure 148 — Clutch Pressure Plate Removed from Pressure Ring

b. Disassemble Release Yoke and Sleeve (fig. 146). Unscrew lubricator tube from release yoke, and remove shifter fork bushings. Remove eight cap screws and lock washers attaching bearing retainer to release yoke. Remove lock ring from groove in release sleeve. Press bearing off release sleeve and out of release yoke. Remove eight cotter pins and pins attaching cam rollers to release sleeve.

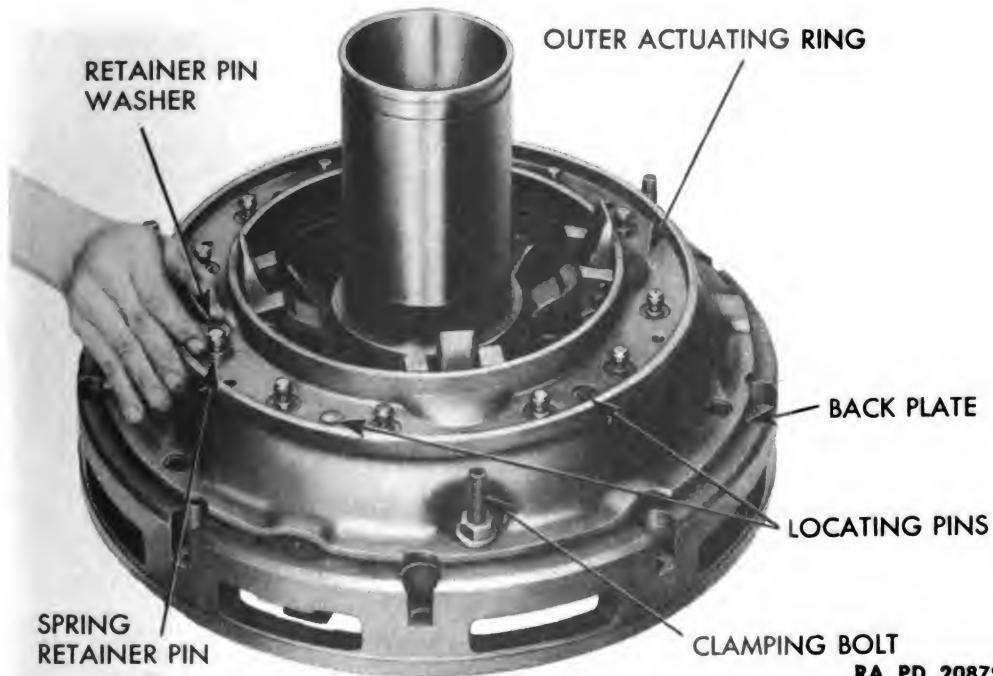


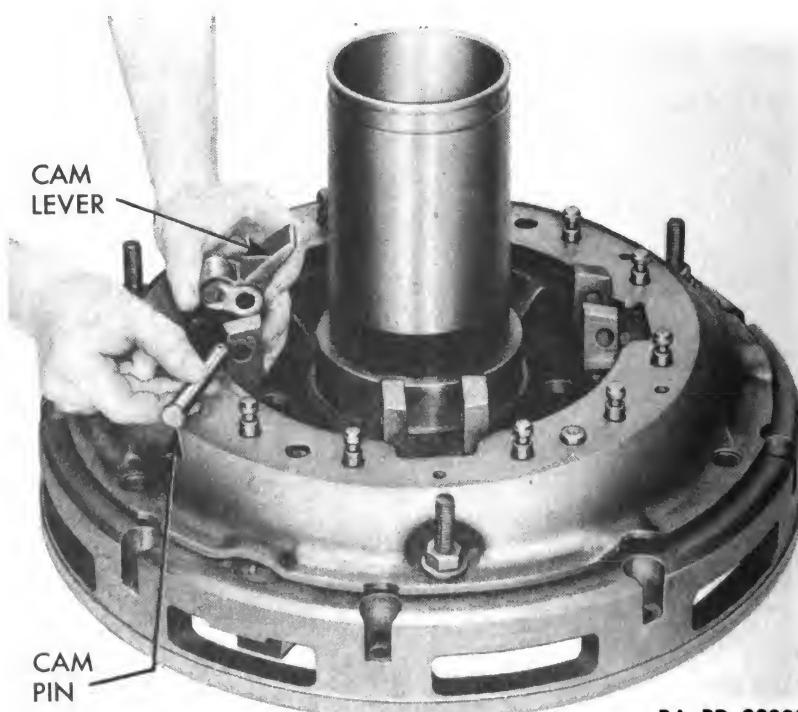
Figure 149 — Removing Clutch Pressure Spring Retaining Pin Washer

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c. Remove Clutch Pressure Plate. Using pressure plate equalizer spring compressor tool (41-C-2555-900) and long-nose pliers, remove three U-washers from equalizer pin (fig. 147). Remove three equalizer spring cap washers, spring, and plain washer from pin. Working from pressure ring side of clutch (fig. 148), remove six outer ring adjusting nuts from studs. Lift pressure plate with studs and driven plate out of back plate.

d. Remove Outer Actuating Ring (fig. 149). Use three cap screws ($\frac{1}{2}$ -20NF-2 x $3\frac{3}{4}$ with $3\frac{5}{8}$ -thread length), three nuts ($\frac{1}{2}$ -20NF-2) (BBBX1E), six heavy plain washers ($\frac{1}{2}$ I.D. x $1\frac{1}{2}$ O.D.), and nine plain washers ($\frac{1}{2}$ I.D. x $1\frac{1}{16}$ O.D.) (BEBX1M), to compress clutch pressure plate compression springs. NOTE: *Transmission oil cooler stabilizing bolt (A331641) can be used for this purpose.* Place two large flat washers on each of the three bolts, and insert them through three holes in back plate from which pressure plate studs were removed. Insert bolts from inside of back plate, spacing them equally in back plate. Install three small flat washers and a nut on each bolt on pressure ring side. Tighten nuts until pressure plate springs are fully compressed, and retainer pin washers can be removed from pins. Remove 12 retainer pin washers from spring retainer pins. Lift outer actuating ring from pressure plate.

e. Remove Clutch Cam Levers (fig. 150). Remove four cotter pins and pins attaching cam levers to back plate. Lift out cam levers.



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Figure 150 — Removing Clutch Cam Lever

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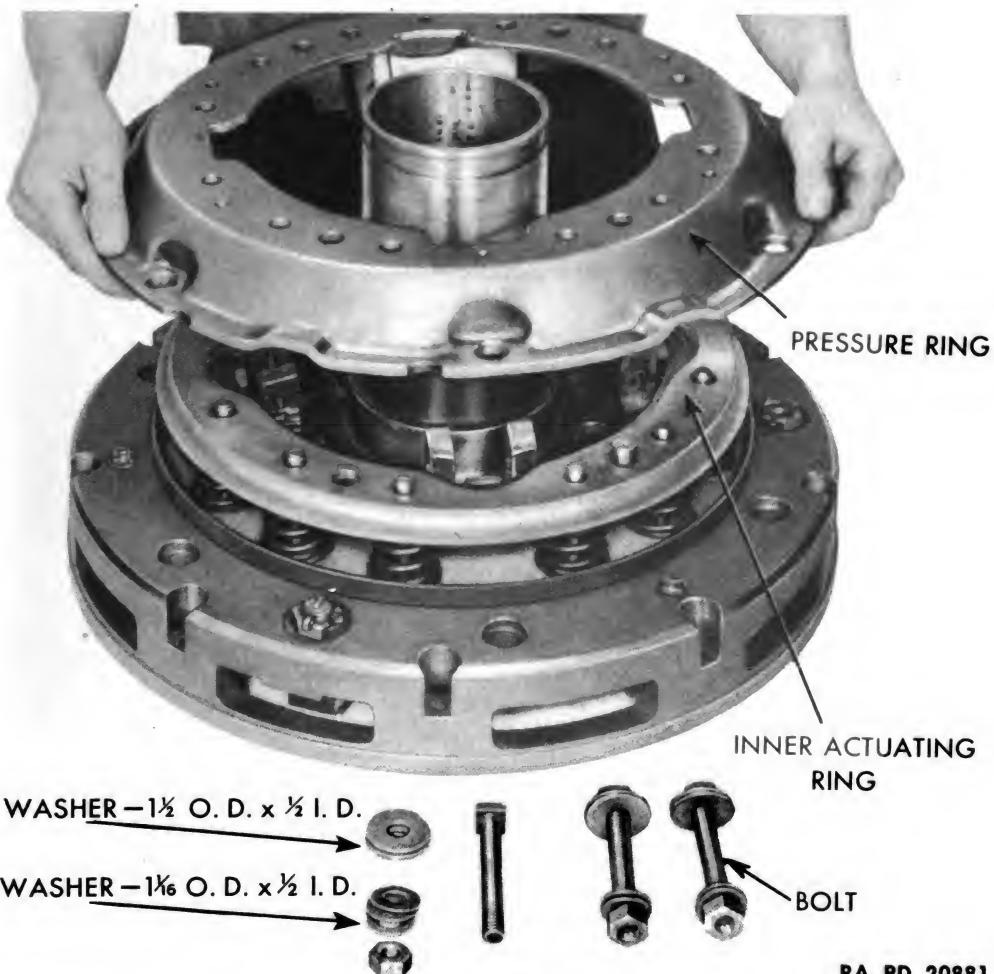


Figure 151 — Removing Clutch Pressure Ring

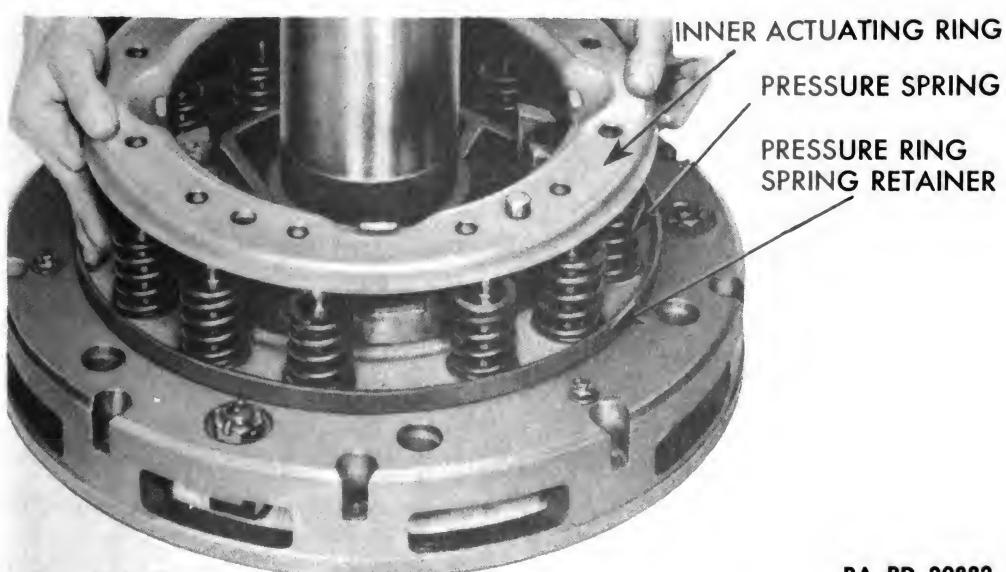
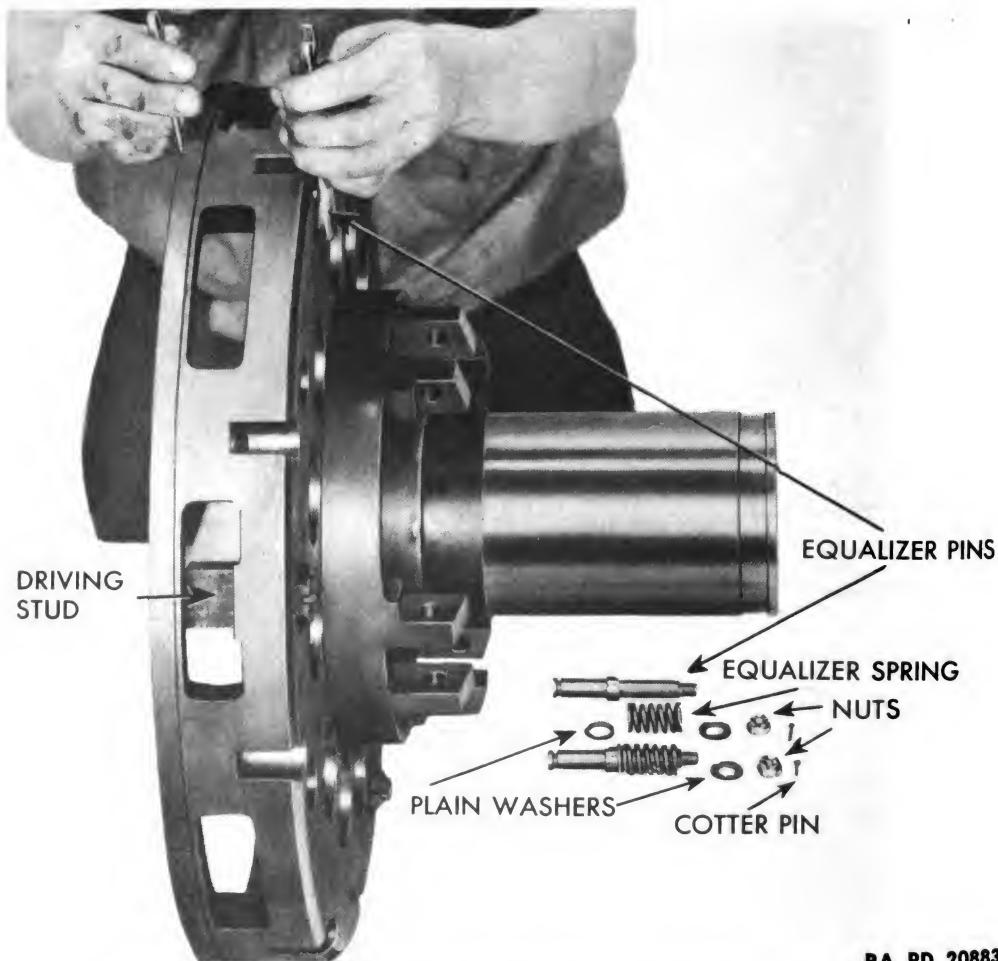


Figure 152 — Removing Clutch Inner Actuating Ring

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f. Remove Clutch Pressure Ring and Pressure Springs. Remove three bolts with six flat washers and nuts clamping pressure ring to back plate. Lift pressure ring from inner actuating ring (fig. 151). Lift inner actuating ring from retainer pins and pressure springs (fig. 152). Remove 12 pressure springs from retainer pins and pressure ring spring retainer. Remove pressure ring spring retainer from back plate, and remove 12 spring retainer pins.



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Figure 153 — Removing Clutch Pressure Plate Equalizer Pin

g. Remove Pressure Plate Equalizer Pins (fig. 153). Remove three cotter pins, nuts, and washers attaching equalizer pins to back plate. Remove three pins, washers, and springs.

92. CLEANING, INSPECTION, AND REPAIR (fig. 154).

a. Clean. Clean all clutch parts thoroughly with dry-cleaning solvent, and dry with compressed air.

(1) **CLEAN BEARING.** Thoroughly clean clutch release yoke bearing in dry-cleaning solvent. Allow it to remain in cleaning

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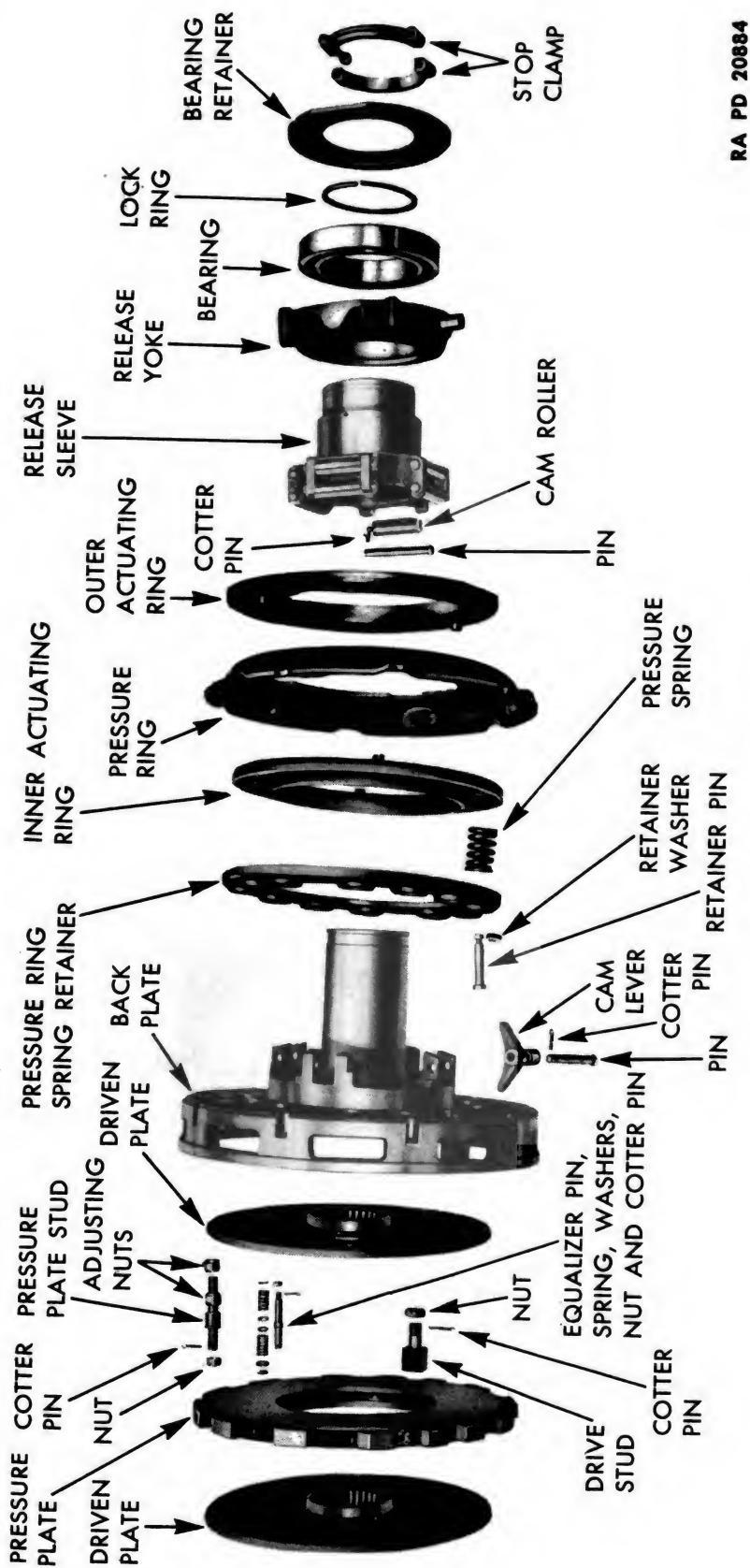


Figure 154 — Engine Clutch Components

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AND PROPELLER SHAFT FOR 13-TON, HIGH-SPEED TRACTOR M5**

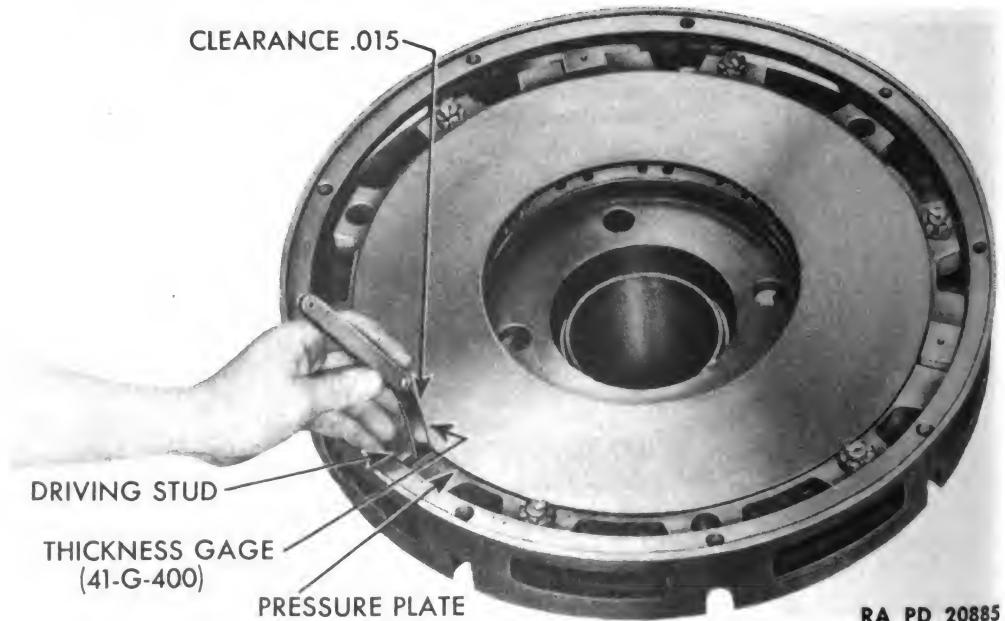
fluid long enough to loosen old grease. Slush bearing in fluid and slowly rotate it below surface of fluid until clean. Blow out bearing, directing air pressure across bearing to remove last traces of old lubricant; avoid spinning bearing by air blast. NOTE: *Bearing must be inspected immediately after cleaning. If in serviceable condition, it should be repacked with grease and wrapped in clean paper until ready for reassembly.*

(2) CLUTCH PRESSURE PLATE. Thoroughly clean out all vent holes in plate.

b. Inspect and Repair.

(1) DRIVEN PLATE ASSEMBLIES. Inspect facings for wear. If facings are worn thin, oil-soaked, or glazed enough to prevent proper engagement, the driven plate assembly must be replaced. Inspect rivets attaching hub and slinger to disk facing assembly. If rivets are loose, replace driven plate assembly. Inspect driven plate for balance. The clutch plate facings must run within 0.010-inch total indicator reading with center line of hub. Inspect splines in hub. If worn excessively or broken, replace driven plate assembly.

(2) PRESSURE PLATE. Inspect for cracks, heat checks, or deep scoring on the contact surfaces of the pressure plate. If the plate is cracked, heat checked, warped, or deeply scored, it must be replaced.



**Figure 155 — Checking Drive Stud Clearance in Pressure Plate,
Using Thickness Gage**

(3) BACK PLATE AND DRIVING STUD ASSEMBLY. Inspect back plate inside surface for cracks, heat checks, or deep scoring; replace if found unserviceable. Inspect surface of quill for scoring, and see

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that it is securely welded to back plate. If scores are so deep that they cannot be removed with crocus cloth, or if the quill is loose, replace complete assembly. Mount back plate in lathe, and check quill for concentricity with a dial indicator. The pilot diameter must be within 0.005-inch indicator reading. The three drive studs in back plate must be tight and parallel with diameter of back plate, and must allow plate to slide freely back and forth. To check driving studs, install driven plate and pressure plate in back plate. With a thickness gage (41-G-400), check clearance between each stud and pressure plate (fig. 155). The clearance between new studs and pressure plate must be 0.015 inch.

(4) **PRESSURE SPRINGS.** Inspect for weak springs. New springs have a free length of $2\frac{3}{4}$ inches, and test 273 to 301 pounds when compressed to a length of $1\frac{3}{16}$ inches. Replace weak springs.

(5) **PRESSURE PLATE EQUALIZER SPRINGS.** Inspect for weak springs. New springs have a free length of $1\frac{1}{8}$ inches, and test 36 to 44 pounds when compressed to a length of $\frac{15}{16}$ inch. Replace weak springs.

(6) **PRESSURE RING, INNER AND OUTER ACTUATOR RINGS, AND SPRING RETAINER.** Inspect the rings and retainer for cracked or warped condition. If rings or retainer are damaged, replace defective part.

(7) **RELEASE YOKE BEARING ASSEMBLY.**

(a) Inspect release bearing for free rolling, for cracked or worn balls, and for worn races. Replace if there is evidence of imperfection.

(b) Inspect sleeve for signs of excessive wear or scores in bore. Replace sleeve bore if worn excessively.

(c) Inspect sleeve cam rollers and pins for signs of wear. Replace if they show wear.

(d) Inspect release yoke bearing lubricator tubes and fittings. Be sure that tubes are not clogged, and that lubricator fitting works properly.

(e) Inspect clutch release yoke and shifter fork bushings for signs of excessive wear. Replace yoke or bushings if the bushings do not fit snugly on yoke.

(8) **ENGINE FLYWHEEL.** Inspect contact surface for cracks, heat checks, or deep scoring. Inspect studs for looseness and proper length. Inspect condition of bore in flywheel for pilot bearing. For replacement or repair of flywheel, refer to paragraphs 12, 13, and 39.

(9) **CAM LEVERS.** Inspect cam levers for signs of excessive wear. Replace if they show wear.

93. ASSEMBLY.

a. **Install Pressure Plate Equalizer Pins** (fig. 153). Place narrow washer and equalizer spring on pin from threaded end, and install pin in back plate from inside surface. Secure three pins to back plate with flat washers, nuts, and cotter pins.

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b. **Install Pressure Spring Retainer, Pressure Springs, and Inner Actuating Ring** (fig. 152). Install 12 retainer pins in spring retainer, and place retainer in position on back plate. Place 12 pressure springs in position on spring retainers. Place inner actuating ring in position on retainer pins and springs so that four depressions in ring line up between cam lever supports on back plate.

c. **Install Pressure Ring and Cam Levers** (figs. 150 and 151). Place pressure ring on inner actuating ring so that inside slots line up between cam lever supports on back plate (fig. 151). Use three cap screws ($\frac{1}{2}$ -20 NF-2 x $3\frac{3}{4}$ with $3\frac{5}{8}$ thread length), three nuts ($\frac{1}{2}$ -20NF-2) (BBBX1E), six heavy plain washers ($\frac{1}{2}$ I.D. x $1\frac{1}{2}$ O.D.), and nine plain washers ($\frac{1}{2}$ I.D. x $1\frac{15}{16}$ O.D.) (BEBX1M), to compress pressure springs. NOTE: *Transmission oil cooler stabilizing bolt (A331641) can be used for this purpose.* Place two large washers on bolts, and insert bolts through pressure plate stud holes in back plate and through pressure ring, with bolt heads on inside of plate. Place three small washers on bolts. Install nuts on bolts, and tighten them until pressure ring contacts back plate. Place four cam levers in position between supports on back plate, and install pins and cotter pins (fig. 150). Insert pins so that they all point in same direction, and with flat side on head against shoulder in support to prevent them from turning.

d. **Install Outer Actuating Ring** (fig. 149). Place actuating ring in position on pressure ring with locating pins through holes in pressure ring. Slice retainer pin washers into slots of spring retainer pins. NOTE: *Install retainer pin washer so that open side is to outside of clutch. This maintains proper balance of clutch assembly.* Remove three bolts and nuts and 15 plain washers clamping pressure plate to back plate. Check to make sure that retaining pin washers are properly seated in countersunk holes of outer actuating ring.

e. **Install Pressure Plate** (fig. 148). Place one clutch driven plate, with oil slinger facing out, in back plate. Before installing pressure plate be sure that faces of six adjusting nuts are set $1\frac{15}{16}$ inches from lug on pressure plate (fig. 148). Install pressure plate in position in back plate. Install six adjusting nuts on pressure plate studs finger-tight.

f. **Install Pressure Plate Equalizer Springs** (fig. 147). Install three plain washers, springs, and cup washers on equalizer pins. With clutch equalizer spring and U-washer compressor (41-C-2555-900), compress equalizer springs, and install U-washers in groove on equalizer pins.

g. **Assemble and Install Clutch Release Sleeve and Yoke.** Install eight cam rollers, pins, and cotter pins in supports on release sleeve (fig. 146). Install pins so they all point in one direction. Press bearing into release yoke. Press bearing and yoke onto release sleeve, and install lock ring in groove around end of sleeve. Install bearing retainer on yoke, and attach with eight cap screws and lock washers. Slide release sleeve assembly on quill extending from back

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plate (fig. 145). Install release stop clamps in groove around end of quill, and attach with two bolts, nuts, and cotter pins (fig. 144). Install shifter fork bushings (fig. 146) on release yoke, and install lubricator tube in end of yoke.

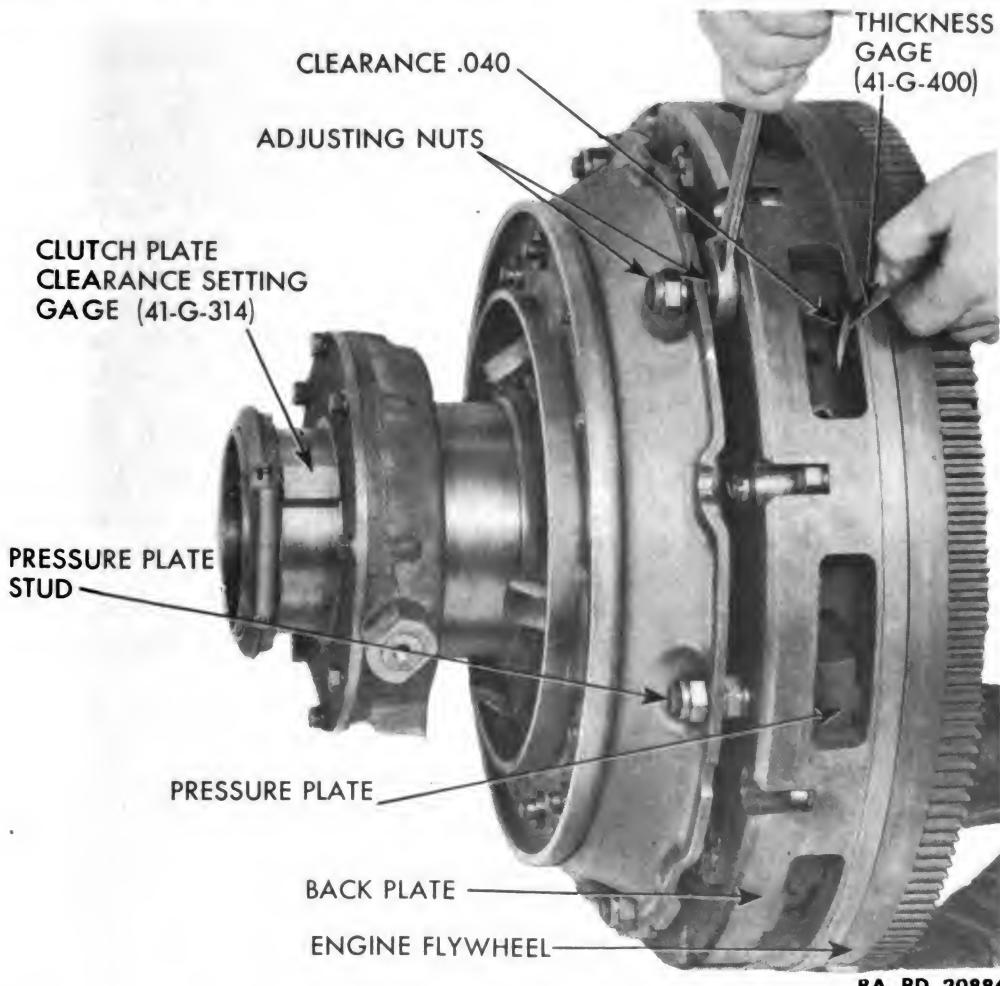


Figure 156 — Adjusting Clutch Pressure Plate with Clutch Plate Clearance Setting Gage and Thickness Gage

h. Adjust Clutch Pressure Plate Clearance (fig. 156). With front driven plate in place, attach clutch assembly to flywheel with nine nuts and lock washers. Using clutch plate clearance setting gage (41-G-314), and thickness gage (41-G-400), adjust pressure plate clearance. Place 1.2-inch long gage (41-G-314) between release bearing retainer and stop clamp. This places clutch in neutral position. Insert 0.040-inch feeler gage between the pressure plate and the driven plate, which is between the flywheel and pressure plate, and adjust the pressure plate with adjusting nuts so the thickness gage (41-G-400) will pass between the two with a slight amount of drag. Repeat this operation at each stud. When pressure plate is adjusted to a uniform clearance all around, and all adjusting nuts are properly tightened, the clutch is ready for use.

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NOTE: *The clutch must be adjusted whenever a new pressure plate or new driven plates are installed. Remove flywheel by removing nine nuts and lock washers.*

94. INSTALLATION.

a. Install Clutch Assembly in Clutch Housing (fig. 142). Set clutch housing on front end and block securely. Hitch a sling through slots in side of clutch back plate, and attach sling to hoisting device. Lift clutch over clutch housing, and lower it onto clutch range drive shafts. Work clutch driven plates onto splines of range drive shafts, and at same time line up shifter fork bushings with shifter fork. Before clutch is lowered all the way down, connect lubricator tube to fitting on shifting shaft, and tighten two cap screws and lock washers clamping shifter fork to shifting shaft. Lower clutch assembly into position, and remove sling. Place rear driven plate on high-range drive shaft with slinger facing out.

b. Install Clutch Shifting Lever (fig. 141). Place Woodruff key in end of shifting shaft, and place shifting lever in position on shaft so that lever is flush with 45-degree chamfer on end of shaft. At the same time, place snubber in position on anchor with one rubber bushing on each side of eye in snubber. Attach with plain washer, nut, and cotter pin. Clamp lever to shaft with cap screw, nut, and lock washer.

c. Install Clutch and Clutch Gear Reduction Unit Assembly (fig. 140). Be sure clutch pilot bearing is in place in flywheel. Shellac a new gasket in place on clutch housing. Attach lifting bracket (41-B-1918-500) to top of clutch housing with four cap screws. With a lifting device and wire rope, lift clutch into position at flywheel end of engine. If clutch is being installed with engine in vehicle, lower unit assembly down and forward under rear fender support cross member. Guide high-range drive shaft into clutch pilot bearing, and clutch back plate onto studs in flywheel. Attach clutch housing to flywheel housing with 12 cap screws and lock washers. Remove lifting bracket from top of clutch housing.

d. Attach Clutch to Flywheel. Secure clutch to flywheel with nine nuts and lock washers on flywheel studs inside of clutch housing around back plate. Work through opening in clutch housing, and rotate engine flywheel with hand crank to install all nuts and lock washers on flywheel studs.

e. Install Clutch Housing Cover (fig. 139). Place new gasket on cover, and place cover in position on clutch housing. Attach it with eight cap screws and lock washers.

f. Install Two Air Reservoir Tanks (fig. 139). Set two air reservoir tanks in position on frame side channels. Install air reservoir tank drain cock control cross rod on drain cock stems so that cocks will be closed when control rod is in downward position. Install eight cap screws and lock washers attaching air reservoir tank brackets to frame side channels. Connect air tank to air

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tank tube to connector fittings on top of tanks. Connect air tube from air compressor to connector fitting on rear tank. Connect air tube from front tank to union.

g. Install Clutch Shifting Lever Rod (fig. 139). Before installing shifting lever rod, check adjustment of clutch shifting lever stop screws (refer to TM 9-786). Place shifting lever rod on shifting lever, and attach with pin and cotter pin.

h. Install Propeller Shaft (fig. 139). Place propeller shaft in position on splined transmission input shaft. Install four cap screws and two lock plates attaching universal joint trunnion bearings to clutch universal joint flange.

i. Install Clutch Release Yoke Bearing Lubricator (fig. 139). Connect lubricator tube to elbow fitting on clutch shifting lever shaft cover.

j. Install Clutch Housing Breather Tube (fig. 139). Attach breather tube to tee at front side of clutch housing.

k. Install Right Fuel Tank Vent Tube (fig. 139). Connect vent tube from right fuel tank to tee fitting at tank and tee. Attach clip under cap screw and lock washer on clutch housing cover, and two clips to air tubes.

l. Install Shell Box Support (fig. 139). Place shell box support in position, and attach with eight cap screws and lock washers.

m. Install Clutch Housing Coolant Elbows (fig. 139). Place hose with hose clamps, and elbows with new gaskets, in position on each side of clutch housing. Attach each elbow with two cap screws and lock washers. Tighten hose clamps attaching hose to coolant pipes and elbows.

n. Install Electric Cables. Place right fuel gage cable through shell box support opening, and connect to terminal with one nut and lock washer. Place right cable harness, tachometer cable, and engine heat indicator cable in clips attached under support. Place left fuel gage cable through shell box opening, and connect to terminal with one nut and lock washer. Place left cable harness in five clips under shell box support.

o. Install Clutch Gear Reduction Unit Oil Filler Tube (fig. 139). Place filler tube nipple with new gasket in position, and attach to clutch housing with three cap screws and lock washers. Install hose with two clamps on nipple. Install filler tube in hose, and attach to shell box support with two cap screws and lock washers. Tighten two hose clamps.

p. Install Coolant Drain Valve (fig. 139). Place rod in position on drain valve at bottom of clutch gear reduction unit, and attach with cotter pin. Install new gasket on drain valve, and attach valve with two cap screws and lock washers.

q. Install Air Tank Drain Valve Handle (fig. 139). Place drain valve handle in position on cross rod lever, and attach with pin and cotter pin.

r. Install Transmission Oil Filter Control Rod. Attach connecting rod to ratchet handle on top of oil filter.

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- s. Fill Cooling System.** Refer to TM 9-786.
- t. Install Shell Box.** Refer to TM 9-786.
- u. Install Center Bottom Plate, Center.** Attach bottom plate to supports and cross member with 18 cap screws and lock washers.
- v. Install Front Center Bottom Plate.** Attach bottom plate to supports and cross member with 25 cap screws and lock washers.

95. TESTS.

- a. Clutch tests** are made after clutch is installed, and with proper air pressure in air system. Observe whether or not clutch disengages when the service clutch pedal is pressed $\frac{2}{3}$ of the way down, or to the point where pressure of bumper spring is felt. Press the service clutch pedal to toeboard, then release. This should change clutch range either from "LOW" to "HIGH", or from "HIGH" to "LOW", as indicated by the jewel lights on instrument panel. Repeat this test several times to make certain of range changes. Observe for grabbing, chattering, or squealing of clutch, and note whether there is any indication of slippage. Be sure clutch driven plates, governed by clutch brake on propeller shaft, stop rotation in normal length of time. If they continue to revolve, it is an indication that driven plates are not being released. Check for oil leaks in clutch gear reduction unit around oil seals and gaskets. Check for coolant leaks around gaskets and hose after engine has been started and heated to operating temperature.

CHAPTER 7 (Cont'd)**CLUTCH GROUP AND PROPELLER SHAFT
(Cont'd)****Section III****ENGINE CLUTCH CONTROLS**

	Paragraph
Description	96
Operation	97
Clutch selector	98
Clutch pedals, rods, and power cylinder lever	99

96. DESCRIPTION (fig. 157).

a. The engine clutch controls include the linking mechanism, from the service and emergency clutch pedals back to the clutch shifting lever, which is located on the side of the clutch housing. The controls consist of the following, in the order in which they are connected, starting with the service and emergency clutch pedals: three rods which connect the pedals to the clutch selector, the clutch selector itself, clutch shifting valve, power cylinder lever, two power cylinders, clutch shifting lever rod, clutch shifting lever, and clutch shifting lever snubber. The purpose of the clutch controls is to enable the operator to disengage or engage the clutch in either high or low range by operating the service clutch pedal when air pressure is normal, or by operating both the service clutch pedal and emergency clutch pedal when there is no air pressure.

b. Service information on the engine clutch controls is covered in this section, with the exception of the two power cylinders and clutch shifting valve, which are covered in TM 9-1786B under the air system.

97. OPERATION (fig. 157).

a. A clutch shifting lever (J), located at the side of the clutch housing (K), controls the engagement or disengagement of the two-way engine clutch. When the lever is in a vertical position, the clutch is disengaged. When it is in a forward position, the clutch is engaged in high range. When it is in a rear position, the clutch is engaged in low range. The movement of the clutch shifting lever is controlled by the operator through the clutch pedals and controls. With normal air pressure (80 to 100 pounds), the operator uses only the service clutch pedal (B) to operate the clutch, and this is referred to as "normal clutch operation" (see subparagraph b). With no air pressure, the operator uses both the service clutch pedal (B) and emergency clutch pedal (A) to operate the clutch manually, and this is referred to as "emergency clutch operation" (subpar. c below). Following is a detailed description of what takes place in the clutch controls when the pedals are moved through

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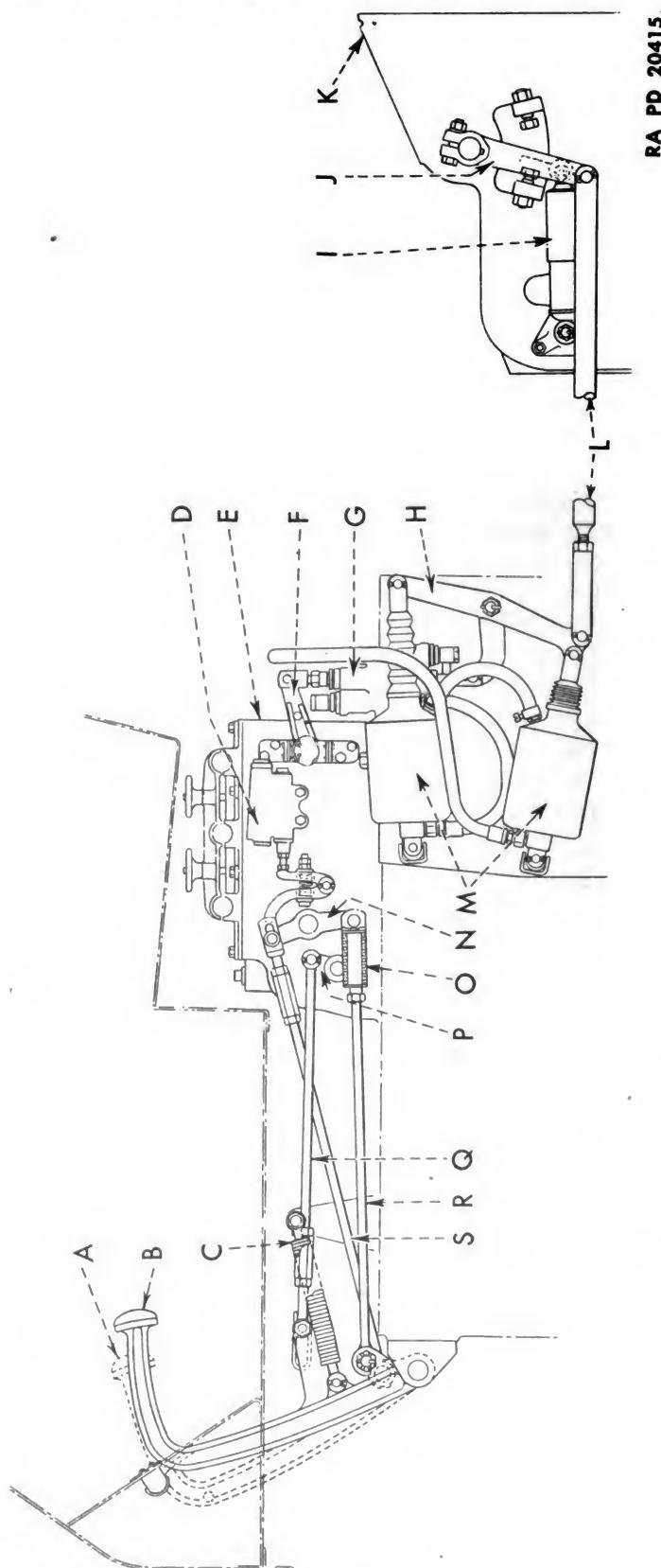


Figure 157 — Engine Clutch Controls — Clutch Engaged in High Range

ENGINE CLUTCH CONTROLS

- A. EMERGENCY CLUTCH PEDAL
- B. SERVICE CLUTCH PEDAL
- C. PEDAL RETURN SPRING
- D. CLUTCH BRAKE APPLICATION VALVE
- E. CLUTCH SELECTOR
- F. CLUTCH SHIFTING VALVE LEVER
- G. CLUTCH SHIFTING VALVE
- H. CLUTCH POWER CYLINDER LEVER
- I. SNUBBER
- J. CLUTCH SHIFTING LEVER
- K. CLUTCH HOUSING
- L. CLUTCH SHIFTING LEVER ROD
- M. POWER CYLINDERS
- N. CLUTCH SELECTOR RANGE LEVER
- O. BUMPER SPRING
- P. CLUTCH SELECTOR TOGGLE LEVER
- Q. CLUTCH SELECTOR ROD
- R. SERVICE CLUTCH PEDAL ROD
- S. EMERGENCY CLUTCH PEDAL ROD

RA PD 20415B

Legend for Figure 157 — Engine Clutch Controls — Clutch Engaged in High Range

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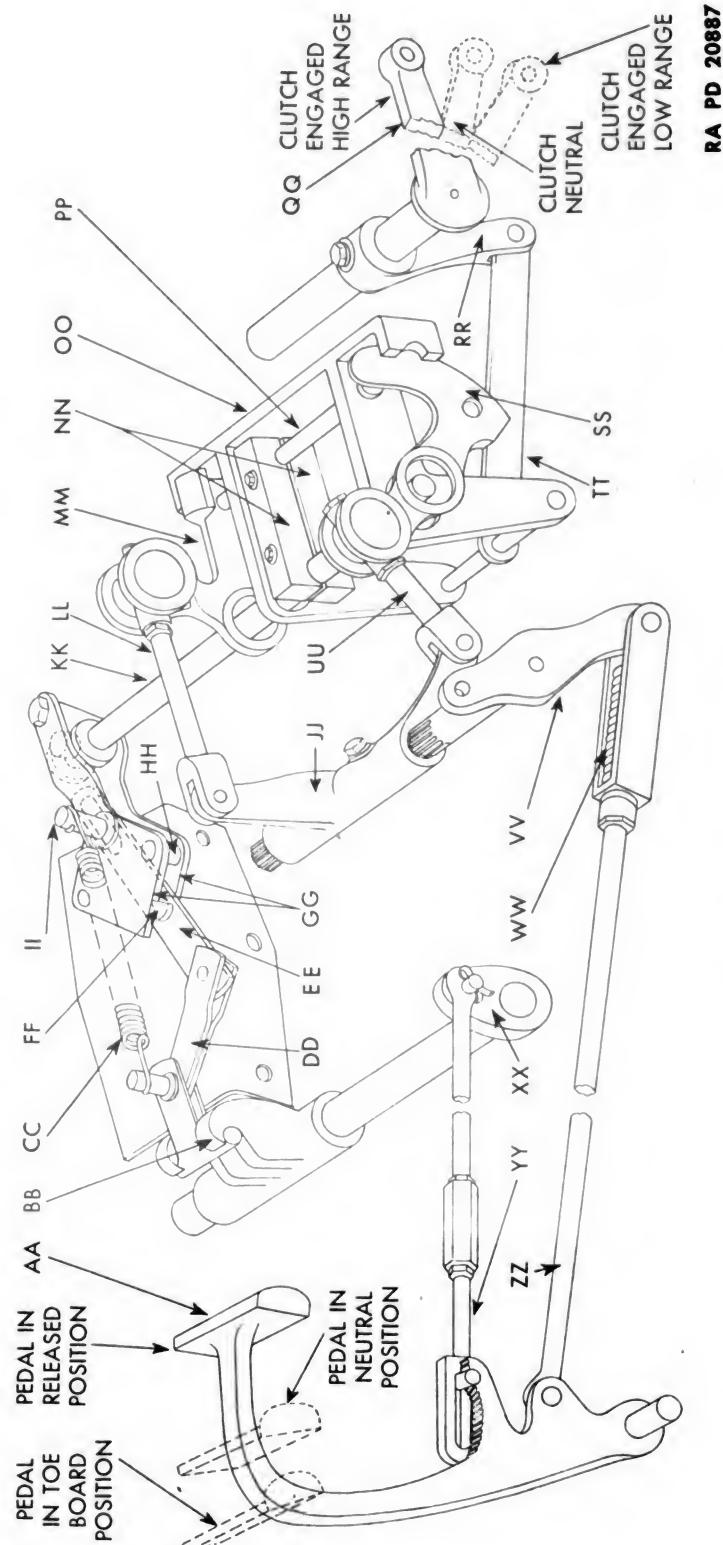


Figure 158 — Schematic Drawing of Clutch Selector — Clutch Engaged
in High Range

ENGINE CLUTCH CONTROLS

AA. SERVICE CLUTCH PEDAL	NN. SHIFTER LEVERS
BB. INNER TOGGLE LEVER	OO. INTERMEDIATE LEVER
CC. OVERCENTER SPRING	PP. SHIFTER LEVER PIN
DD. FRONT TOGGLE OPERATING ARM	QQ. CLUTCH SHIFTING VALVE LEVER
EE. REAR TOGGLE OPERATING ARM	RR. INNER VALVE LEVER
FF. GUIDE PIN	SS. LOW RANGE LEVER
GG. TOGGLE PLATES	TT. VALVE LEVER LINK
HH. STOP PIN	UU. LOW RANGE ROD WITH YOKE
II. PIVOT PIN	VV. CLUTCH SELECTOR RANGE LEVER
JJ. INNER RANGE LEVER	WW. BUMPER SPRING
KK. SHIFTER ROD	XX. CLUTCH SELECTOR TOGGLE LEVER
LL. HIGH RANGE ROD WITH YOKE	YY. CLUTCH SELECTOR ROD
MM. HIGH RANGE LEVER	ZZ. SERVICE CLUTCH PEDAL ROD

RA PD 20887 B

*Legend for Figure 158 — Schematic Drawing of Clutch Selector — Clutch Engaged
in High Range*

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their various positions to operate the engine clutch, both with normal clutch operation and emergency clutch operation.

b. **Normal Clutch Operation.** When air pressure is normal (80 to 100 pounds) the operation of the clutch is as follows:

(1) **CLUTCH ENGAGED.** When the service clutch pedal is released, all the way up, the engine clutch is engaged in either high or low-range. Figures 157 and 158 show the clutch controls in high-range. Note in figure 157 that the clutch shifting lever (J), which is located at the side of the clutch housing, is in the high-range position against the forward stop screw.

(2) **DISENGAGE CLUTCH** (figs. 157 and 158). When the service clutch pedal (AA) is depressed to neutral, approximately $\frac{2}{3}$ of the way down, it moves the service clutch pedal rod (ZZ), and also the lower end of the clutch selector range lever (VV), forward. The clutch selector range lever shaft is splined to the inner-range lever (JJ), which is located inside the selector housing. This inner-range lever (JJ) has an upper arm, which is connected to the high-range lever (MM) by a rod with yoke (LL), and a lower arm, which is connected to the low-range lever (SS) by a rod with yoke (UU). Forward movement of the lower end of the clutch selector range lever (VV) causes the high-range lever (MM) to move down, and the low-range lever (SS) to move up. This movement, up or down, is transferred to the intermediate lever (OO) by a sliding shifting lever pin (PP). When the pin engages a hole provided in the high-range lever (MM), the intermediate lever (OO) moves with the high-range lever. When the pin engages the low-range lever (SS), the intermediate lever (OO) moves with the low-range lever. Since we are disengaging the clutch from high-range, the shifter lever pin (PP) is engaged into the high-range lever (MM), and the intermediate lever (OO) moves down with the high-range lever until it strikes a stop on the low-range lever (SS). In this position the holes in both the high and low-range levers are in line with the shifting lever pin, and the pin could be moved endwise to engage either lever if it were free to do so. The downward movement of the intermediate lever (OO) is transferred through the valve lever link (TT) and the inner valve lever (RR) to the clutch shifting valve lever (QQ), causing the latter to move down to a horizontal position. The clutch shifting valve lever (QQ) is linked to the power cylinder lever (H) by a shifting valve (G). This is a follow-up type of valve that controls the flow of air pressure to the power cylinders (M). These power cylinders actuate the power cylinder lever (H) in proportion to the movement of the clutch shifting valve lever (F). The downward movement of the clutch shifting valve lever (F) causes the lower power cylinder to push the lower end of the power cylinder lever (H) toward the rear. It also moves the clutch shifting lever rod (L) and the clutch shifting lever (J) toward the rear until the clutch shifting lever is positioned midway between the two stop screws. This disengages the clutch.

(3) **CLUTCH DISENGAGED** (fig. 158). Depressing the service clutch pedal (AA) from neutral to the toeboard does not affect the

ENGINE CLUTCH CONTROLS

engine clutch in any way; it merely affects the toggle which is located on the side of the clutch selector housing. As the service clutch pedal (AA) is depressed past neutral, the selector range lever (VV) remains stationary, and the movement of the pedal and rod is absorbed by the bumper spring (WW) in the clutch selector rod. The service clutch pedal selector rod (YY) and the clutch selector toggle lever (XX) also move forward with the service clutch pedal as the pedal is moved down to the toeboard. This movement is transferred to an inner toggle lever (BB), which pulls against the tension of two overcenter springs (CC), and moves the front toggle operating arm (DD) ahead, until the two toggle operating arms (DD and EE) line up straight.

(4) **CLUTCH DISENGAGED** (fig. 158). When the service clutch pedal is released back to neutral, the toggle lever (XX) also moves back. This permits the two toggle operating arms (DD and EE) to move backward, due to the pulling force of the toggle overcenter springs (CC). As the toggle operating arms (DD and EE) move backward, a guide pin (FF) in the rear arm contacts the toggle plates (GG), and slides along the diagonal sides of the plates until the arm strikes a stop pin (HH) between the two plates. When this happens, the toggle plates pivot on the pin (II), and move the shifter rod (KK) sideways. The shifter rod (KK) is connected to the rear end of the toggle plates, and is also connected to the shifting lever pin (PP) by the shifting levers (NN). When the shifter rod (KK) moves, the shifting levers (NN) and the shifting lever pin (PP) move with it, thereby disengaging the high-range lever (MM) and engaging the low-range lever (SS).

(5) **ENGAGE CLUTCH** (figs. 157 and 158). As the service clutch pedal (AA) is released from neutral, the lower end of the clutch selector range lever (VV) moves back, and the low-range lever (SS) moves down, carrying with it the intermediate lever (OO). This movement is transferred through the valve lever link (TT), inner valve lever (RR), clutch shifting valve lever (QQ), clutch shifting valve (G), power cylinder lever (H), and clutch shifting lever rod (L), to the clutch shifting lever (J), causing it to move to the rear position and engage the clutch in low-range. This completes the shifting of the engine clutch from high-range to low-range. A snubber (I) is attached between the clutch shifting lever (J) and the anchor mounted on the side of the clutch housing (K). Its purpose is to suppress the forces set up by the power cylinders which operate the clutch, and thus protect the clutch mechanism and two stop screws from unnecessary shock. The stop screws limit the travel of the clutch shifting lever (J).

c. **Emergency Clutch Operation.** When air pressure is lacking, manual operation of the clutch becomes necessary. This operation is as follows:

(1) **CLUTCH ENGAGED.** When the engine clutch is engaged in high-range, the controls are in the position shown in figures 157 and 158.

(2) **DISENGAGE CLUTCH** (figs. 157 and 158). The operation of disengaging the engine clutch without the aid of air pressure

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is strictly a manual operation. The clutch shifting valve (G) serves as a mechanical link between the clutch shifting valve lever (F) and the power cylinder lever (H). As the service clutch pedal (B) is depressed, the bumper spring (O) in the service clutch pedal rod (R) will compress before the clutch selector range lever (N) begins to move. Further movement of the service clutch pedal causes the lower ends of the range lever (N), and the inner range lever (JJ), to move forward. At the same time, the toggle lever (P) is pulled forward by the service clutch pedal selector rod (Q). The movement of the inner-range lever (JJ) is transferred to the high-range lever (MM), and to the low-range lever (SS), through the rods with yokes (LL and UU). The intermediate lever (OO) moves with the high-range lever (MM), due to the shifting lever pin (PP) being engaged in the high-range lever. The movement of the intermediate lever (OO) is transferred-- through the valve lever link (TT), inner valve lever (RR), clutch shifting valve lever (QQ), clutch shifting valve (G), power cylinder lever (H), and clutch shifting lever rod (L), to the clutch shifting lever (J). The clutch shifting lever moves to a vertical position midway between the stop screws disengaging the clutch from high-range. As previously mentioned, the toggle lever (XX) is pulled forward when the service clutch pedal is pushed to the toeboard. This movement, explained in subparagraph b (4), causes the toggle operating arms (DD and EE) to pull into a straight line. When the operator removes his foot from the service clutch pedal, the pedal will return only part way. This is due to the pull of the return spring (C) on the service clutch pedal, and the pull of the two toggle overcenter springs (CC). The toggle overcenter springs also pull the toggle operating arms (DD and EE) back until the guide pin (FF) in the rear arm contacts the diagonal faces of the toggle plates (GG). The guide pin then slides along the diagonal faces of the toggle plates until the rear arm strikes the stop pin (HH), between the plates, causing the toggle plates to pivot on pin (II), with the arm. The shifter rod (KK) moves with the rear end of the toggle plates (GG), and carries with it the shifting levers (NN) and the shifting lever pin (PP). The pin disengages the high-range lever (MM), and engages the low-range lever (SS). The intermediate lever (OO) then moves with the low-range lever (SS).

(3) ENGAGE CLUTCH (figs. 157 and 158). The emergency clutch pedal (A) is connected to the upper end of the clutch selector range lever (N) by the emergency clutch pedal rod (S). Movement of the emergency clutch pedal (A) to the toeboard causes the upper end of the range lever (N) to move forward. This movement is transferred (through the inner range lever (JJ) and the rod with yoke (UU)) to the low-range lever (SS), which moves down. The intermediate lever (OO) also moves down with the low-range lever (SS), due to the engagement of the shifting lever pin (PP). The downward movement of the intermediate lever (OO) is transferred, through the valve lever link (TT), inner valve lever (RR), clutch shifting valve lever (QQ), clutch shifting valve (G), power cylinder lever

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(H), and clutch shifting lever rod (L), to the clutch shifting lever (J), which moves to the rear position against the rear stop screw. This engages the engine clutch in low-range.

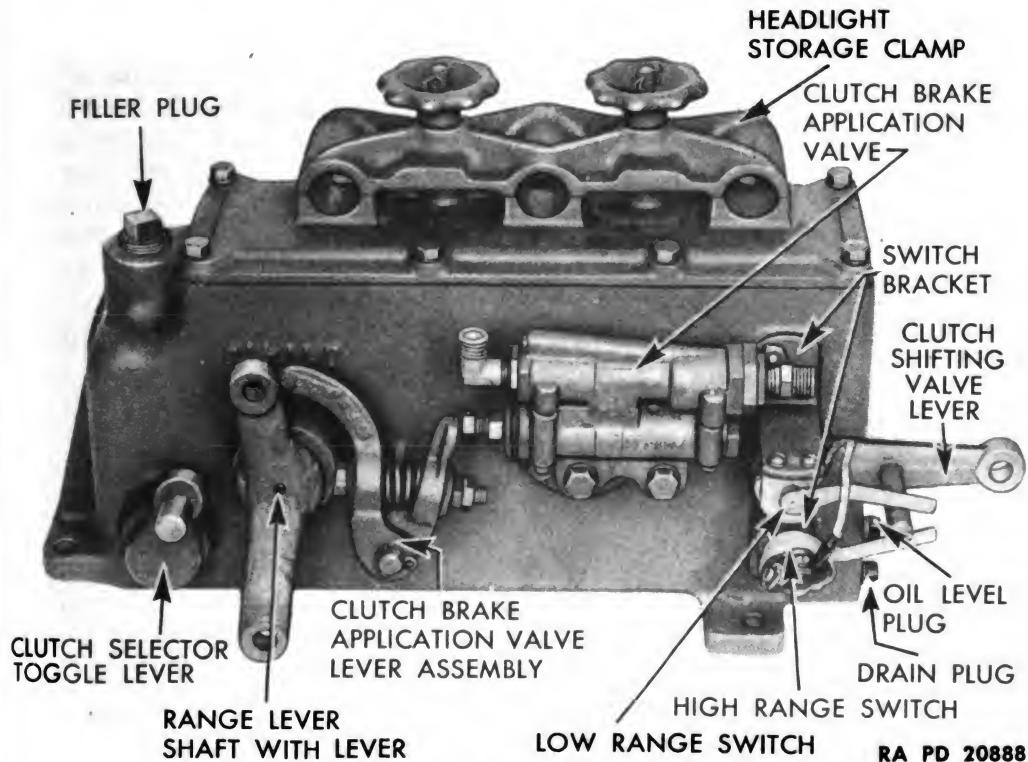


Figure 159 — Left Side View of Clutch Selector

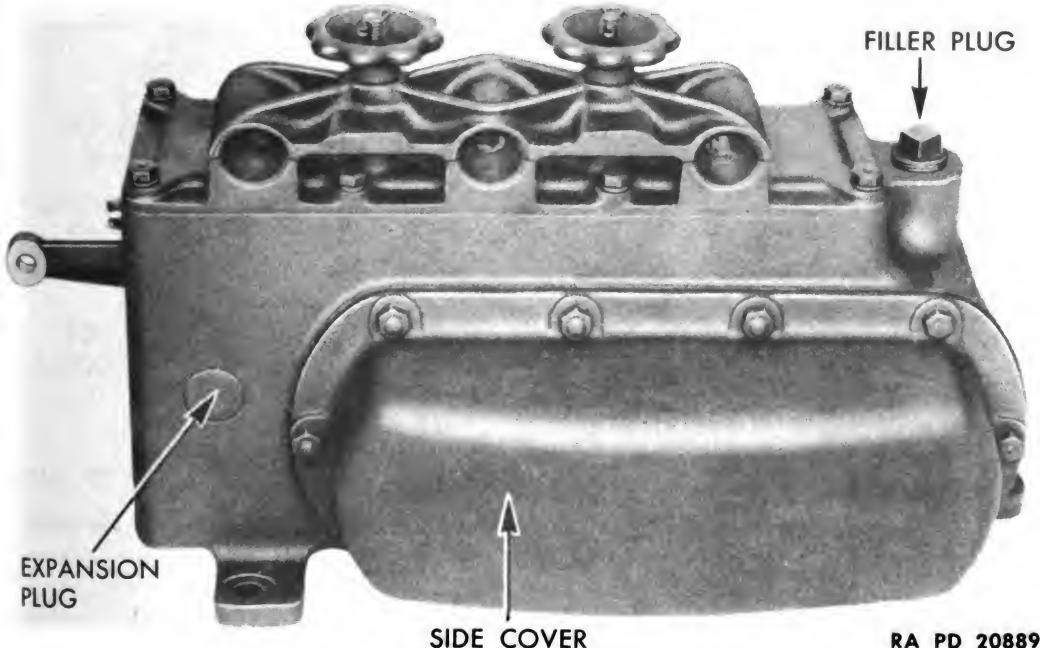
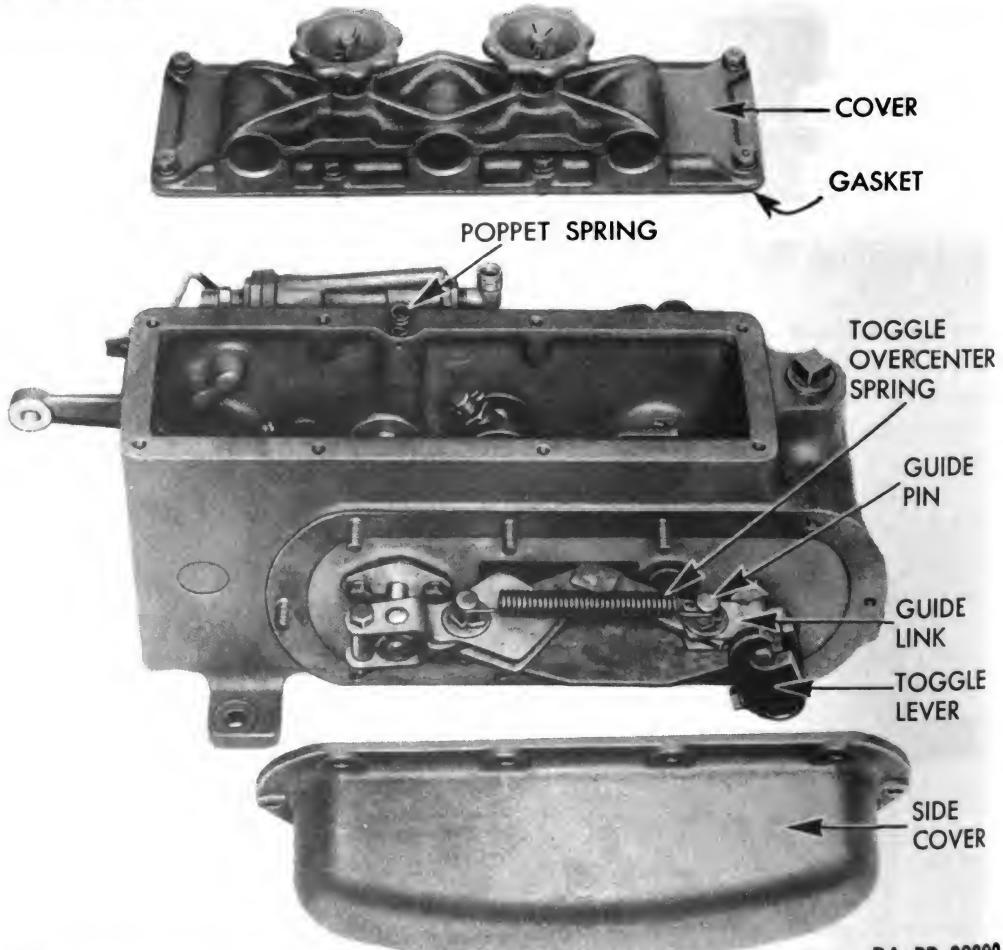


Figure 160 — Right Side View of Clutch Selector

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98. CLUTCH SELECTOR.

a. **Description** (figs. 159 and 160). The clutch selector is part of the clutch controls. It consists of a housing, with cover, containing the mechanism which enables the operator to shift the clutch to neutral, or engage it in either high or low range, by actuating the service clutch pedal, when air pressure is normal, or both the service clutch pedal and emergency clutch pedal when there is no air pressure. The clutch selector is located below the driver's seat. On its cover is a clamp for storing the three headlights. Mounted to the side of the selector housing is the clutch brake application valve, which controls the application of the clutch brake. The two clutch range light switches are mounted to brackets on the side of the clutch selector housing, and are operated by the clutch shifting valve lever.



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Figure 161 — Cover and Side Cover Removed from Clutch Selector Housing

b. Disassemble.

(1) **DRAIN OIL.** Remove drain plug at the rear of clutch selector (fig. 159), and drain oil.

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(2) REMOVE CLUTCH SELECTOR HOUSING COVER (fig. 161). Remove eight cap screws with lock washers attaching cover to housing. Remove cover and gasket.

(3) REMOVE CLUTCH SELECTOR HOUSING SIDE COVER (fig. 161). Remove 6 cap screws, 4 nuts, and 10 lock washers attaching side cover to housing. Remove side cover and gasket from housing.

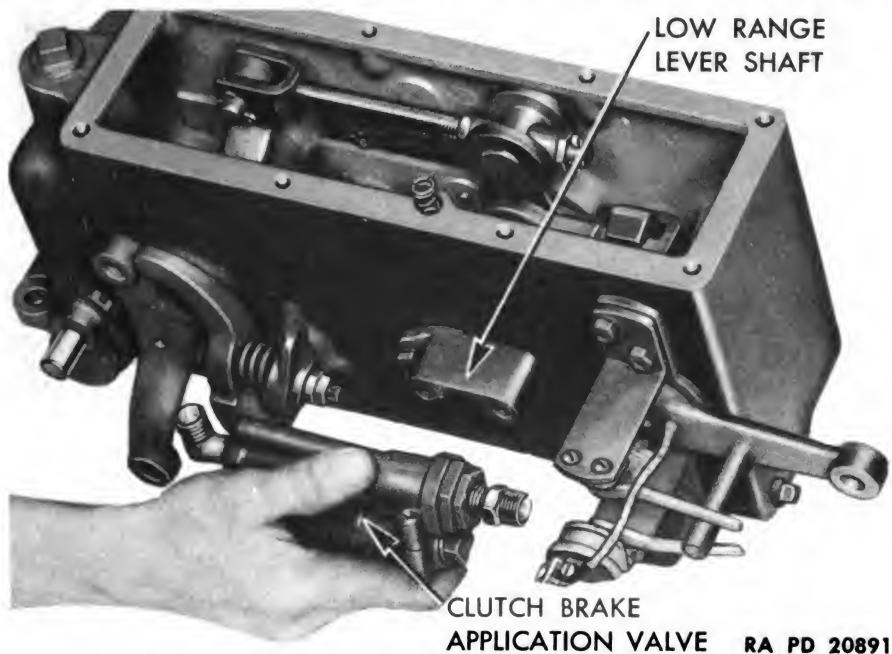


Figure 162 — Removing Clutch Brake Application Valve

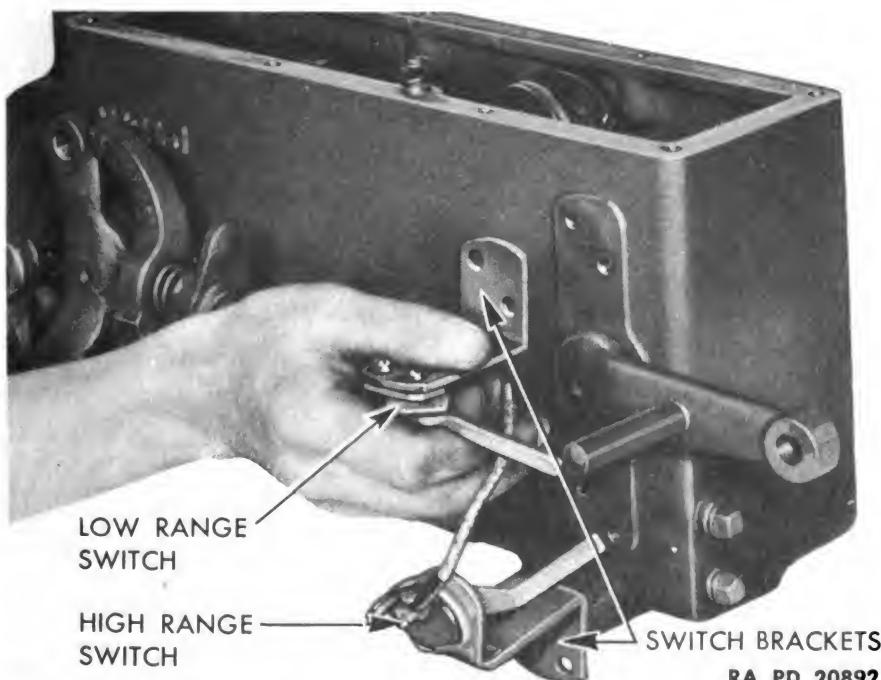


Figure 163 — Removing Range Switches and Brackets

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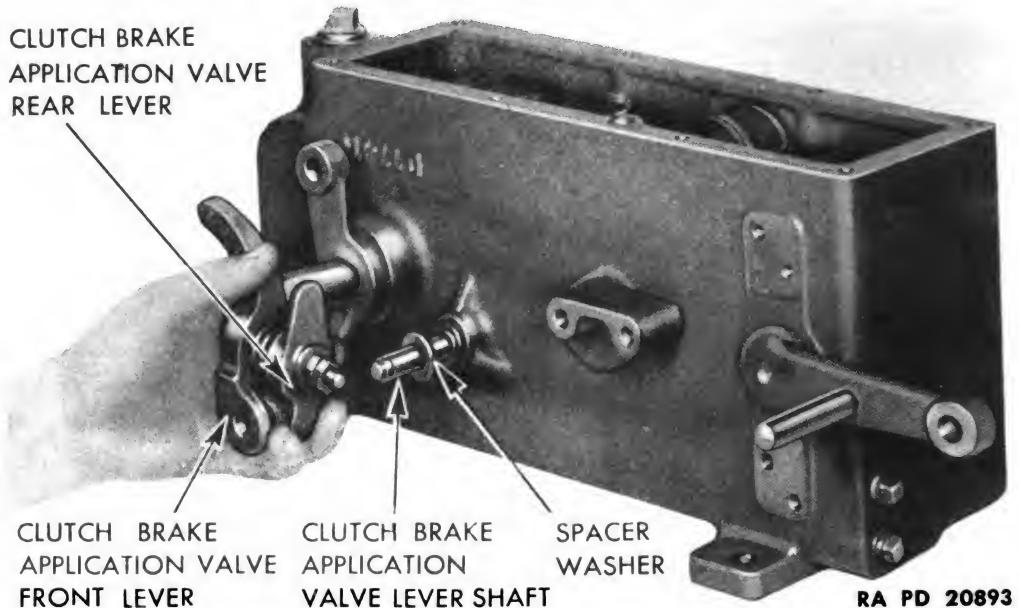


Figure 164 — Removing Clutch Brake Application Valve Lever Assembly

(4) REMOVE CLUTCH BRAKE APPLICATION VALVE (fig. 162). Remove two cap screws and lock washers attaching valve to end of low range lever shaft.

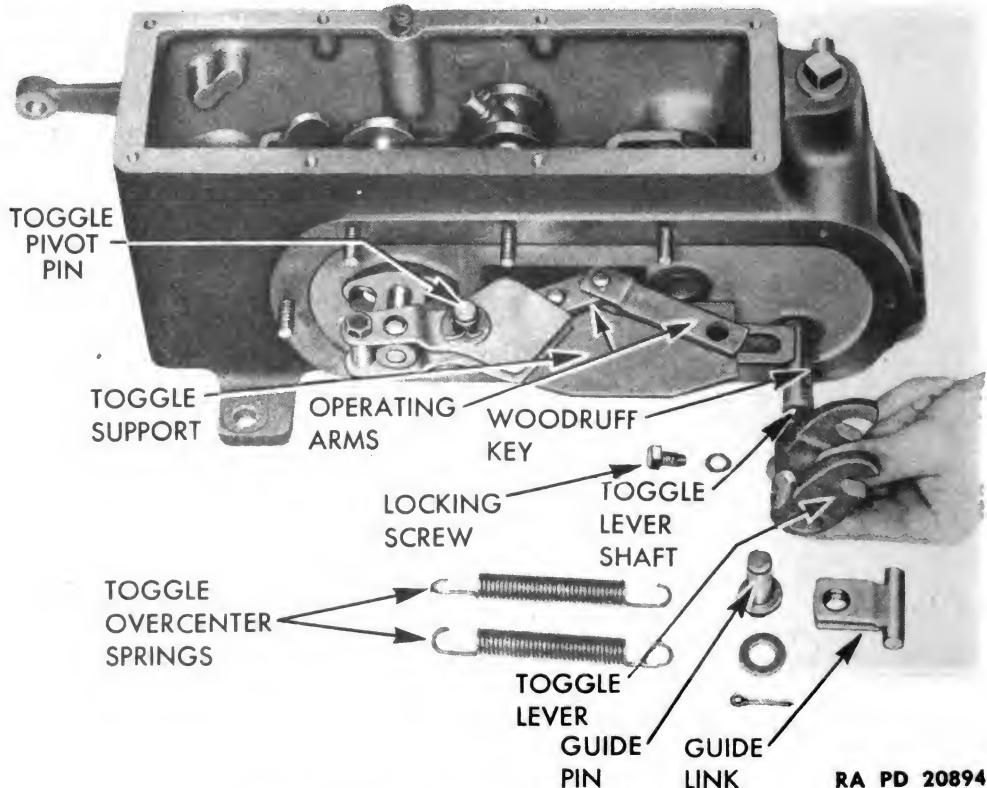


Figure 165 — Removing Toggle Lever

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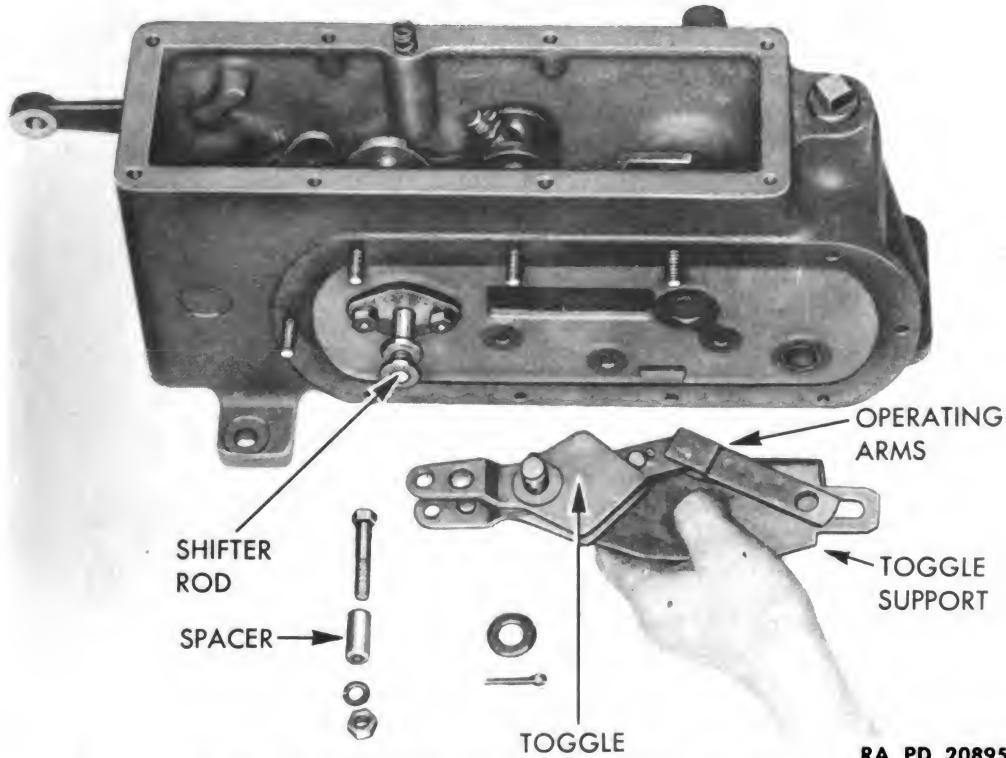


Figure 166 — Removing Toggle Support Assembly

(5) REMOVE CLUTCH LOW AND HIGH RANGE SWITCHES AND BRACKETS (fig. 163). Remove two cap screws with lock washers attaching each switch bracket to housing.

(6) REMOVE CLUTCH BRAKE APPLICATION VALVE LEVER ASSEMBLY (fig. 164). Remove cotter pin attaching lever assembly to valve lever shaft. Remove lever assembly and spacer washer from shaft.

(7) REMOVE TOGGLE OVERCENTER SPRINGS (fig. 165). Remove two springs from upper and lower ends of guide pin and toggle pin.

(8) REMOVE TOGGLE GUIDE LINK (fig. 165). Remove one cotter pin, plain washer, and guide pin attaching guide link to slot in toggle support. Remove guide link from toggle lever and operating arms.

(9) REMOVE TOGGLE LEVER AND SHAFT (fig. 165). Remove locking screw and lock washer attaching toggle lever to shaft. Remove lever and Woodruff key from lever shaft. Pull toggle lever shaft from housing.

(10) REMOVE TOGGLE SUPPORT ASSEMBLY (fig. 166). Remove three cap screws and lock washers attaching support to housing. Remove cap screws, nut, lock washer, and spacer clamping toggle to shifter rod. Remove toggle support from housing.

(11) REMOVE TOGGLE AND OPERATING ARMS (fig. 166). Remove cotter pin and plain washer attaching toggle and operating arms to toggle support pin.

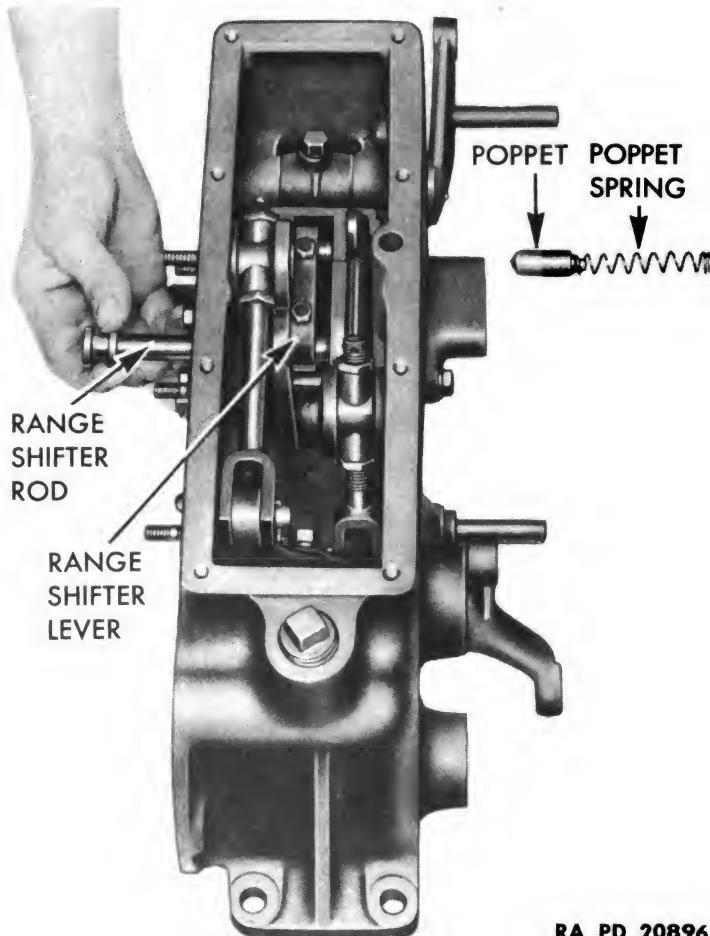
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Figure 167 — Removing Range Shifter Rod

(12) REMOVE CLUTCH RANGE SHIFTER Rod (fig. 167). Loosen two cap screws clamping the two range shifting levers. Remove poppet spring and poppet. Slide range shifter rod out from between range shifting levers, and remove.

(13) REMOVE LEVER ASSEMBLY (fig. 168). Remove two cap screws and lock washers attaching high range lever shaft, and pull shaft out. Remove two cap screws and lock washers attaching low range lever shaft, and pull out shaft and gasket. Remove locking cap screws and lock washers from both inner range lever and inner valve lever. Remove clutch selector range lever and clutch shifting valve lever from housing. Lift lever assembly out of clutch selector housing (fig. 169).

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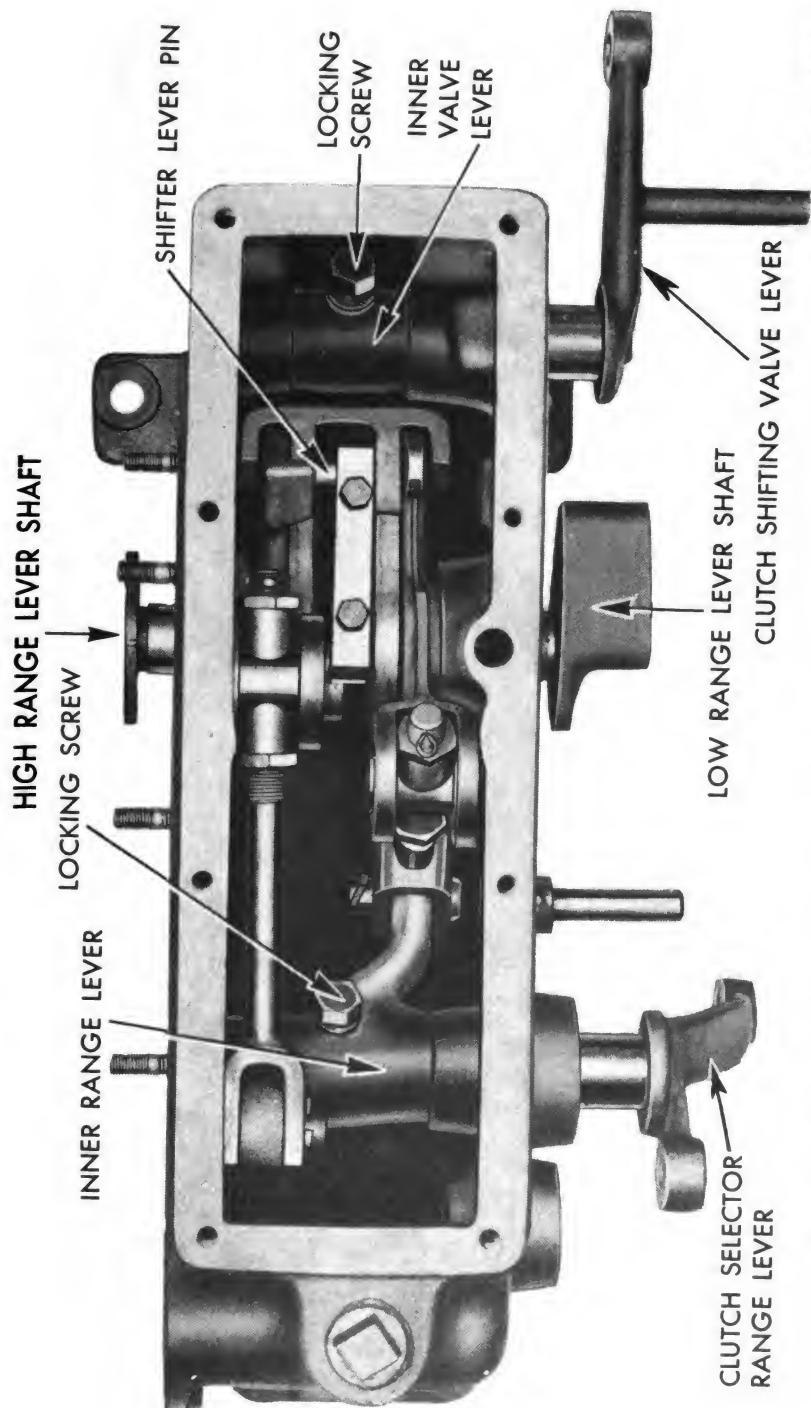


Figure 168 — View in Clutch Selector Housing Preparatory to Removing Lever Assembly

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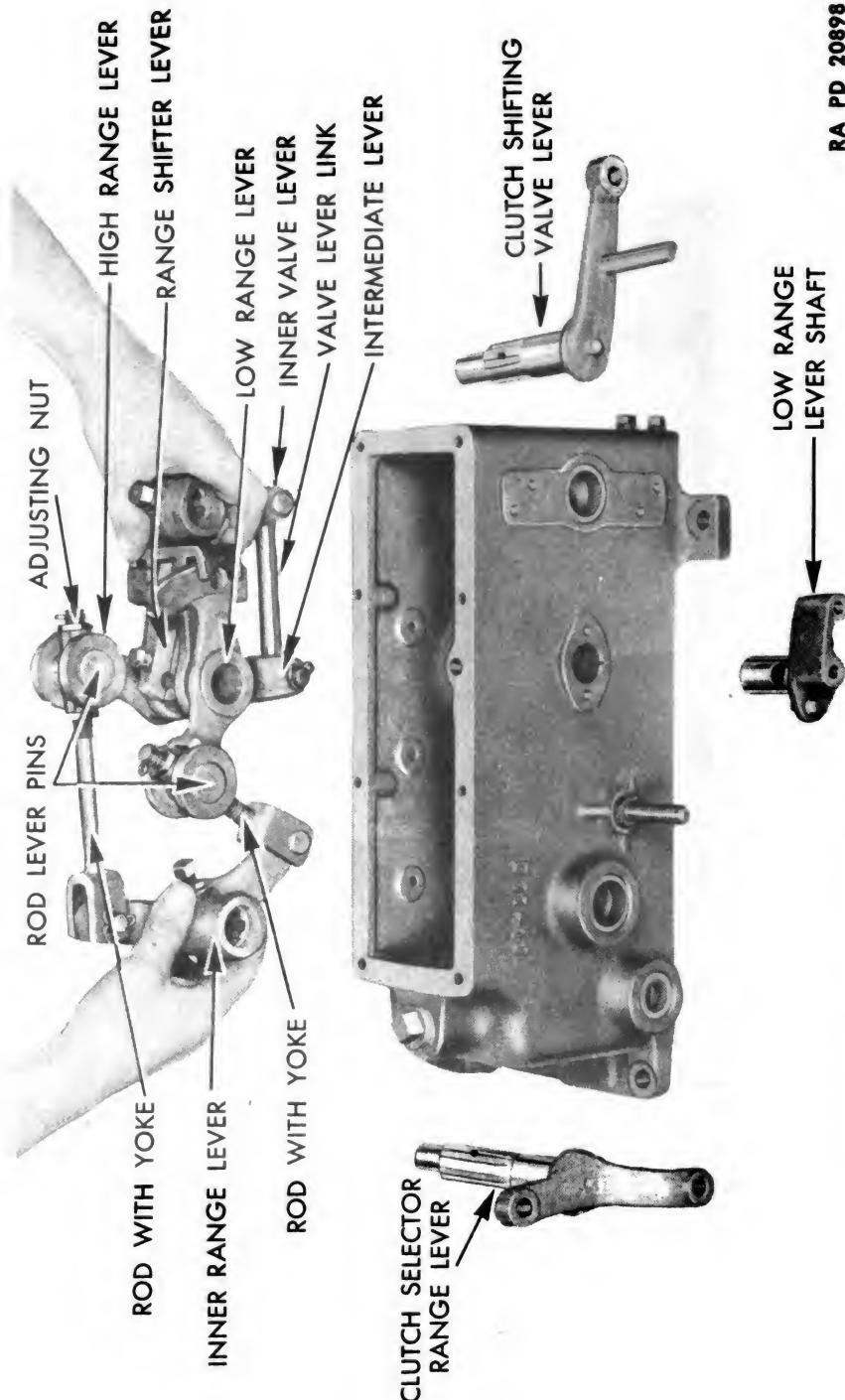


Figure 169 — Removing Lever Assembly from Clutch Selector Housing

ENGINE CLUTCH CONTROLS

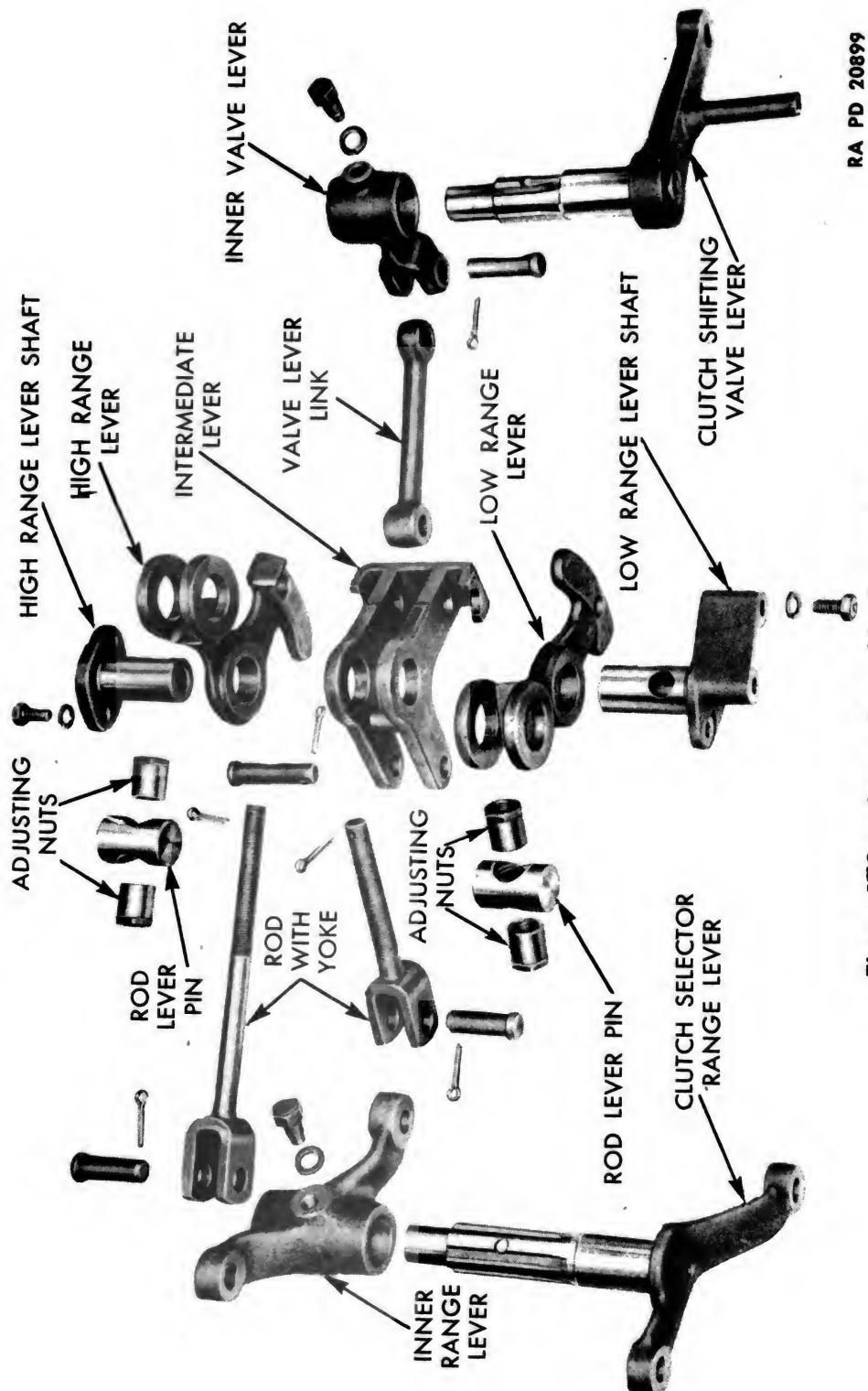


Figure 170 — Lever Assembly Components

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(14) **REMOVE INNER VALVE LEVER** (fig. 170). Remove cotter pin and pin attaching inner valve lever to valve lever link. Remove lever.

(15) **REMOVE INTERMEDIATE LEVER.** Loosen two cap screws and lock washers clamping two range shifting levers to shifting lever pin, and remove lever, shifting lever pin, and intermediate lever (figs. 168 and 169). *CAUTION: Keep the two range shifting lever cap screws in place so that levers will remain in matched position.* Remove cotter pin and pin attaching valve lever link to intermediate lever.

(16) **REMOVE INNER RANGE LEVER** (fig. 169). Remove two cotter pins and two pins attaching rod with yoke to upper and lower ends of inner range lever, and remove lever.

(17) **REMOVE RODS WITH YOKES** (fig. 170). Remove one cotter pin and adjusting nut connecting high range lever to rod. Pull rod from rod lever pin. Remove one cotter pin and adjusting nut connecting low range lever to rod. Pull rod from rod lever pin.

c. **Clean.** Clean all parts thoroughly with dry-cleaning solvent. Use compressed air to blow surfaces clean and dry. Strip off all gaskets from housing, and clean all surfaces where sealing compound has been used.

d. Inspect and Repair.

(1) **CLUTCH SELECTOR HOUSING.** Check housing for cracks. If cracked, replace housing. Check expansion plug in housing for oil leaks, and replace if loose. Check studs in housing for looseness and damaged threads. Replace with new studs if damaged.

(a) *Bushings.* Inspect bushings for excessive wear or damaged condition. Replace with new bushings if worn excessively or damaged.

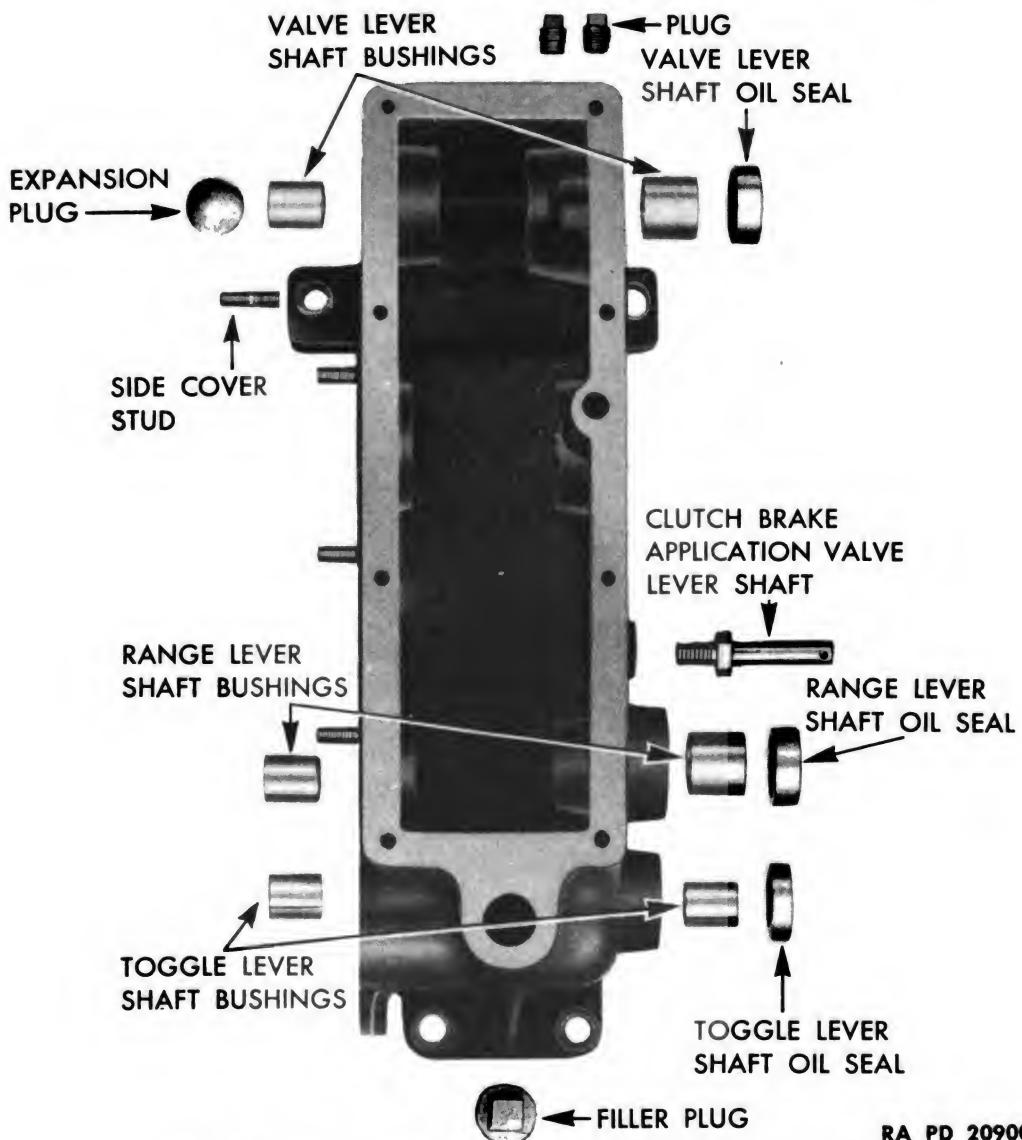
(b) *Oil Seals.* Inspect oil seals, and replace if worn excessively or damaged.

(2) **LEVERS, SHAFTS AND RODS.** Check all parts for excessive wear or improper fitting. Replace parts that are excessively worn or damaged.

(3) **TOGGLE SPRINGS.** Check toggle springs for breakage or weakness. If damaged, replace.

e. **Rebuild** (fig. 171). Rebuilding of clutch selector housing consists of pressing out excessively worn or damaged bushings and oil seals, and replacing with new bushings and oil seals. Four bushings are line-reamed 0.7505 to 0.7535 inch, and two bushings are line-reamed 1.0625 to 1.0655 inches. If a new bushing is required for the small end of valve lever shaft, knock out expansion plug. Replace expansion plug after installing new bushing. Unless the four studs for attaching the side cover extend $\frac{3}{4}$ inch from housing when tight, they should be replaced.

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Figure 171 — Clutch Selector Housing Components

f. Assemble.

- (1) **INSTALL LOWER ROD WITH YOKE** (fig. 170). Place rod with yoke and one adjusting nut through rod lever pin in low range lever, and attach with adjusting nut and cotter pin, leaving adjusting nuts loose.
- (2) **INSTALL UPPER ROD WITH YOKE** (fig. 170). Place rod with yoke and one adjusting nut through rod lever pin in high-range lever, and attach with adjusting nut and cotter pin, leaving adjusting nuts loose.
- (3) **INSTALL INNER RANGE LEVER** (fig. 170). Attach yoke end of lower rod to lower arm of range lever with pin and cotter pin. Attach yoke end of upper rod to upper arm of range lever with pin and cotter pin.

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(4) **INSTALL INTERMEDIATE LEVER** (fig. 170). Place intermediate lever between high and low-range levers. Install range shifting lever pin through holes in high-range lever, intermediate lever, and low-range lever. Place range shifting levers over recessed section of pin within the intermediate lever.

(5) **INSTALL INNER VALVE LEVER** (fig. 170). Attach inner valve lever to valve lever link with pin and cotter pin. Attach link to intermediate lever lower arm with pin and cotter pin.

(6) **INSTALL LEVER ASSEMBLY** (figs. 168 and 169). Place lever assembly inside clutch selector housing. Place clutch shifting valve lever shaft through oil seal and bushing in housing, and through inner valve lever. Be careful not to damage oil seal. Attach in place by tightening locking screw and lock washer. Place new gasket on low-range lever shaft, and insert shaft into housing, and through low-range lever and intermediate lever. Attach low-range lever shaft to clutch selector housing with two cap screws and lock washers. Insert high-range lever shaft into housing and through high-range lever and intermediate lever. Attach high-range lever shaft to clutch selector housing with two cap screws and lock washers. Place clutch selector range lever through oil seal, bushing, and inner-range lever; secure in place by tightening locking screw and lock washer in inner-range lever.

(7) **INSTALL RANGE SHIFTER ROD** (fig. 167). Place shifter rod through high range lever shaft and hole between range shifting levers, and into low range lever shaft. With shifting levers located over recessed section of range shifter rod, clamp levers in position by tightening two cap screws and lock washers. Make sure that shifting levers with range shifter rod and shifting lever pin work freely from one range to the other, when high and low-range levers are in neutral position. *NOTE: Refer to adjustment, subparagraph g, before proceeding further with assembly of clutch selector.* Place shifter rod poppet and spring in socket provided in side of housing.

(8) **INSTALL TOGGLE** (fig. 166). Place slotted end of toggle operating arms inside toggle, and place on pivot pin on toggle support. Attach with washer and cotter pin. Attach toggle support to housing with three cap screws and lock washers. Attach toggle to shifter rod by installing spacer, cap screw, nut, and lock washer.

(9) **INSTALL TOGGLE LEVER AND SHAFT** (fig. 165). Insert toggle lever shaft through oil seal and bushings in clutch selector housing. Insert Woodruff key in shaft, and place toggle lever on shaft, attaching with locking screw and lock washer.

(10) **INSTALL TOGGLE GUIDE LINK** (fig. 165). Place guide link in position through fork of toggle lever and over toggle arm and toggle support. Attach with guide pin, washer, and cotter pin. Check toggle assembly to make sure each part works freely.

(11) **INSTALL TOGGLE OVERCENTER SPRINGS** (fig. 165). Hook

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springs over ends of toggle pivot pin and toggle guide pin, using grooves provided in pins.

(12) **INSTALL CLUTCH SELECTOR HOUSING SIDE COVER** (fig. 161). Attach new gasket and cover to clutch selector housing with 6 cap screws, 4 nuts, and 10 lock washers.

(13) **INSTALL CLUTCH SELECTOR HOUSING COVER** (fig. 161). Place new gasket and cover in position on housing, and attach with eight cap screws and lock washers.

(14) **INSTALL RANGE LIGHT SWITCHES** (fig. 163). Attach high and low-range light switch brackets to housing with four cap screws and lock washers.

(15) **INSTALL CLUTCH BRAKE APPLICATION VALVE** (fig. 162). Attach clutch brake application valve to low-range lever shaft on side of housing with two cap screws and lock washers.

(16) **INSTALL CLUTCH BRAKE APPLICATION VALVE LEVER ASSEMBLY** (fig. 164). Place spacer washer and lever assembly on clutch brake application valve lever shaft, in that order, and attach with cotter pin.

(17) **FILL CLUTCH SELECTOR TO PROPER LEVEL WITH LUBRICATING OIL.** Refer to TM 9-786.

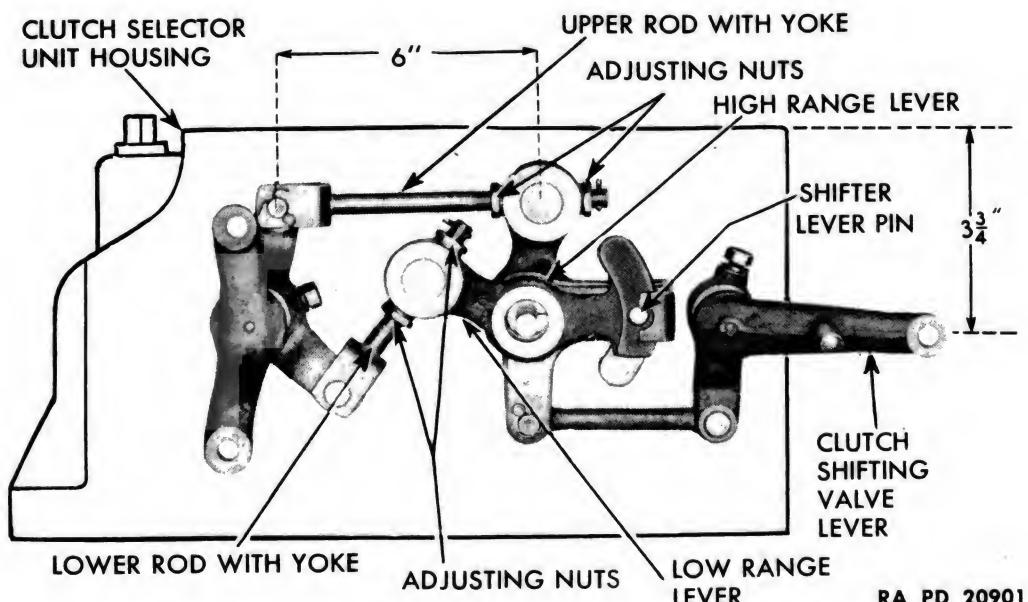


Figure 172 — Clutch Selector Linkage

g. Adjust.

(1) To adjust the clutch selector, first drain the oil, and then remove housing cover, side cover, and toggle support assembly (subpar. b (1) to (10) inclusive).

(2) Turn adjusting nuts on upper rod with yoke to a measurement of 6 inches between the center of the pin in the yoke to the center of the pin in the high-range lever (fig. 172). Then tighten adjusting nuts securely.

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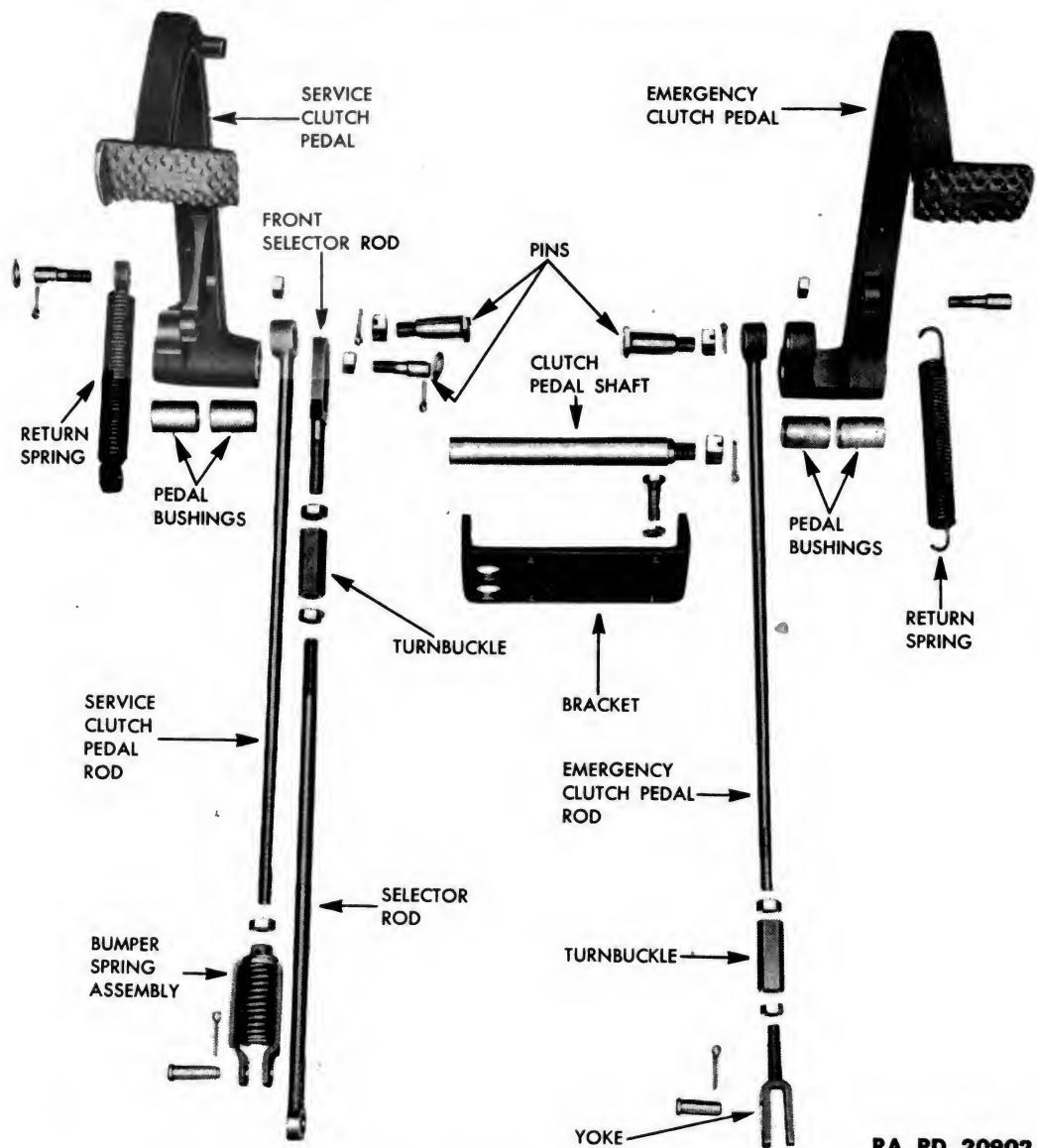


Figure 173 — Clutch Pedals and Rods Disassembled

(3) Move shifting lever pin sideways until the high-range lever, intermediate lever, and low-range lever are locked together by shifting lever pin. Turn adjusting nuts on lower rod with yoke until the clutch shifting valve lever is in a horizontal position. This horizontal position can be checked with a measurement of $3\frac{3}{4}$ inches from the top finished surface of the selector housing to the center of the pin hole in the end of the lever (fig. 172). To measure this distance, place a straightedge across the top finished surface of the clutch selector housing, extending the straight edge over the clutch shifting valve lever. Adjust nuts on lower rod with yoke so that the distance from the straightedge to the center of

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the pin hole in the clutch shifting valve lever is $3\frac{3}{4}$ inches. When adjustment is correct, tighten adjusting nuts on lower rod with yoke securely. The shifting lever pin must slide sideways freely when clutch shifting valve lever is in horizontal position.

99. CLUTCH PEDALS, RODS, AND POWER CYLINDER LEVER.

a. Clean and Inspect (fig. 173).

- (1) Clean all parts with dry-cleaning solvent, and dry with compressed air.
- (2) Inspect oilite bushings in clutch pedals, and replace if excessively worn. Inside diameter of new clutch pedal bushings is 1.1251 to 1.1268 inches.
- (3) Inspect oilite bushings in power cylinder lever, and replace if excessively worn. Inside diameter of new power cylinder lever bushings is 1.0020 to 1.0025 inches.
- (4) Inspect pin holes in clutch pedal rods and power cylinder lever for wear. Replace with new rods or lever if pin holes are excessively worn.
- (5) Inspect bumper spring on service clutch pedal rod, and replace with new bumper spring assembly, if broken.

b. Repair (fig. 173).

- (1) CLUTCH PEDAL BUSHINGS. Supporting pedal on its side, drive out both bushings. Drive new bushings into both ends of hole until flush, with differential and final drive housing cover steering lever bushing remover and replacer (41-R-2375-430).
- (2) POWER CYLINDER LEVER. Supporting lever on its side, and using a long rod or drift, drive bushing out lower side. Turn lever over and drive second bushing out. Drive new bushings into lever with a 1.0023 to 1.0028-inch removing and replacing tool until flush with face of lever hub.

CHAPTER 7 (Cont'd)

CLUTCH GROUP AND PROPELLER SHAFT (Cont'd)

Section IV

CLUTCH BRAKE

	Paragraph
Description and operation	100
Removal and disassembly	101
Cleaning, inspection, and repair	102
Assembly and installation	103

100. DESCRIPTION AND OPERATION.

a. **Description.** The clutch brake is located at the rear of the transmission. It is attached by a shaft to the transmission input shaft rear bearing retainer. The braking mechanism consists of a brake shoe, brake lever, and brake lever actuator. The brake shoe contacts the brake drum, which is welded to the propeller shaft flange. A spring between the brake lever and brake lever actuator gives equal braking intensity each time the brake is applied. The brake is applied by depressing the service clutch pedal, and is operated by air pressure through the clutch brake application valve and power cylinder. The valve and power cylinder are described in TM 9-1786B. Adjustment of the clutch brake is described in TM 9-786.

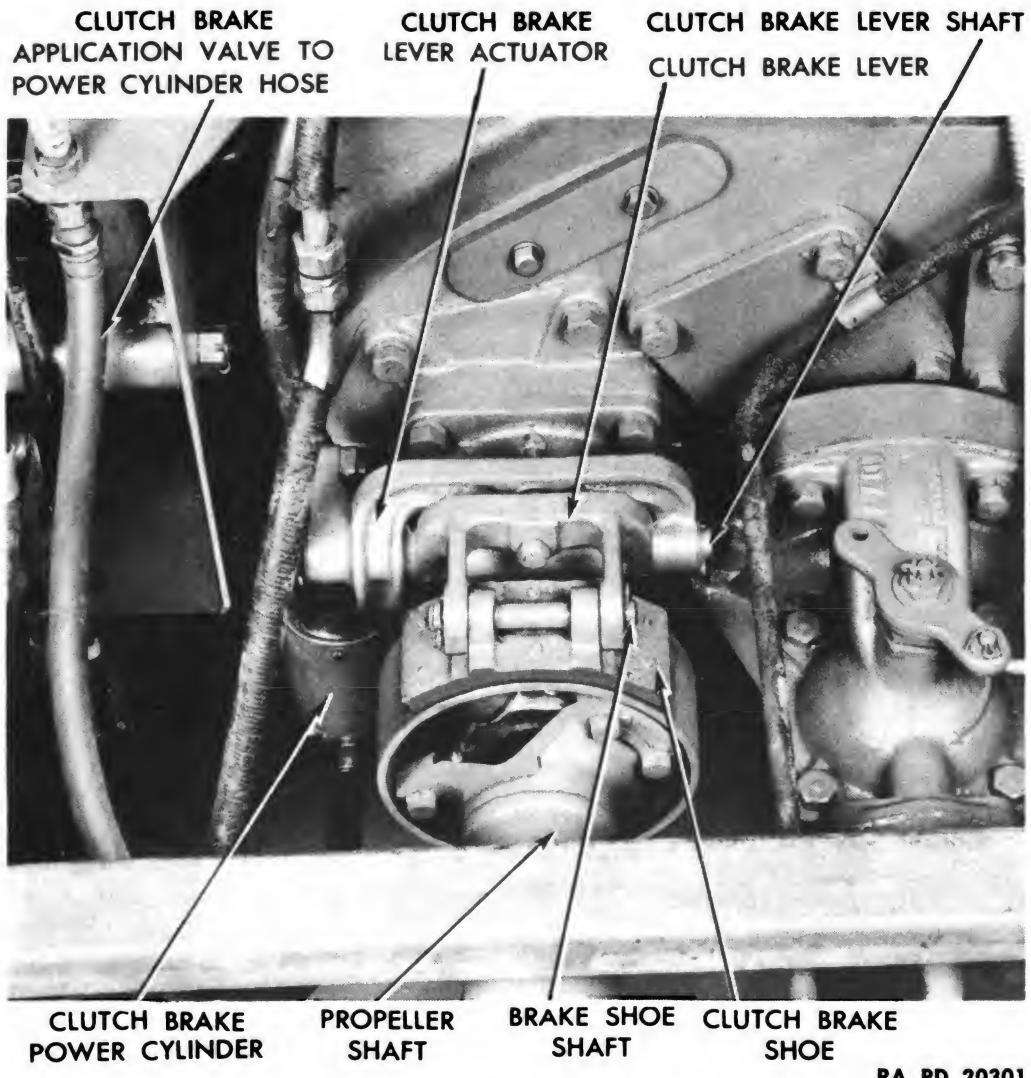
b. **Operation.** The clutch brake slows down the transmission gear train to facilitate shifting the transmission when the engine clutch is disengaged. When the service clutch pedal is depressed to neutral position, the two levers on the side of the clutch selector actuate the clutch brake application valve, and allow air to enter the clutch brake power cylinder. The movement of the power cylinder piston and rod applies the clutch brake. As soon as the service clutch pedal is released, the application valve shuts off the air pressure to the power cylinder, and a spring within the power cylinder pushes the piston and rod back, releasing the pressure on the clutch brake.

101. REMOVAL AND DISASSEMBLY.

a. **Remove Shell Box.** Refer to TM 9-786.

b. **Remove Clutch Brake** (fig. 174). Remove cotter pin and pin attaching brake lever actuator to clutch brake power cylinder. Remove cotter pin and washer from brake lever shaft. Remove brake lever shaft from brake lever actuator and from transmission input shaft bearing retainer, and remove clutch brake assembly.

CLUTCH BRAKE



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Figure 174 — Clutch Brake Installation

c. Remove Clutch Brake Lever Spring (fig. 175). Remove two adjusting nuts and one cap screw holding spring between lever actuator and lever.

d. Remove Brake Shoe (fig. 175). Remove cotter pins from shaft attaching brake shoe to brake lever, and remove shaft and brake shoe.

102. CLEANING, INSPECTION AND REPAIR.

a. Clean. Wash clutch brake parts thoroughly in dry-cleaning solvent, and dry with compressed air.

b. Brake Lever Shaft. Inspect brake lever shaft for excessive wear, and for alinement. If excessively worn or bent, replace shaft.

c. Brake Lever and Actuator. Inspect holes in lever and actuator for excessive wear, and inspect parts for cracks or breaks. Replace parts if excessively worn or broken.

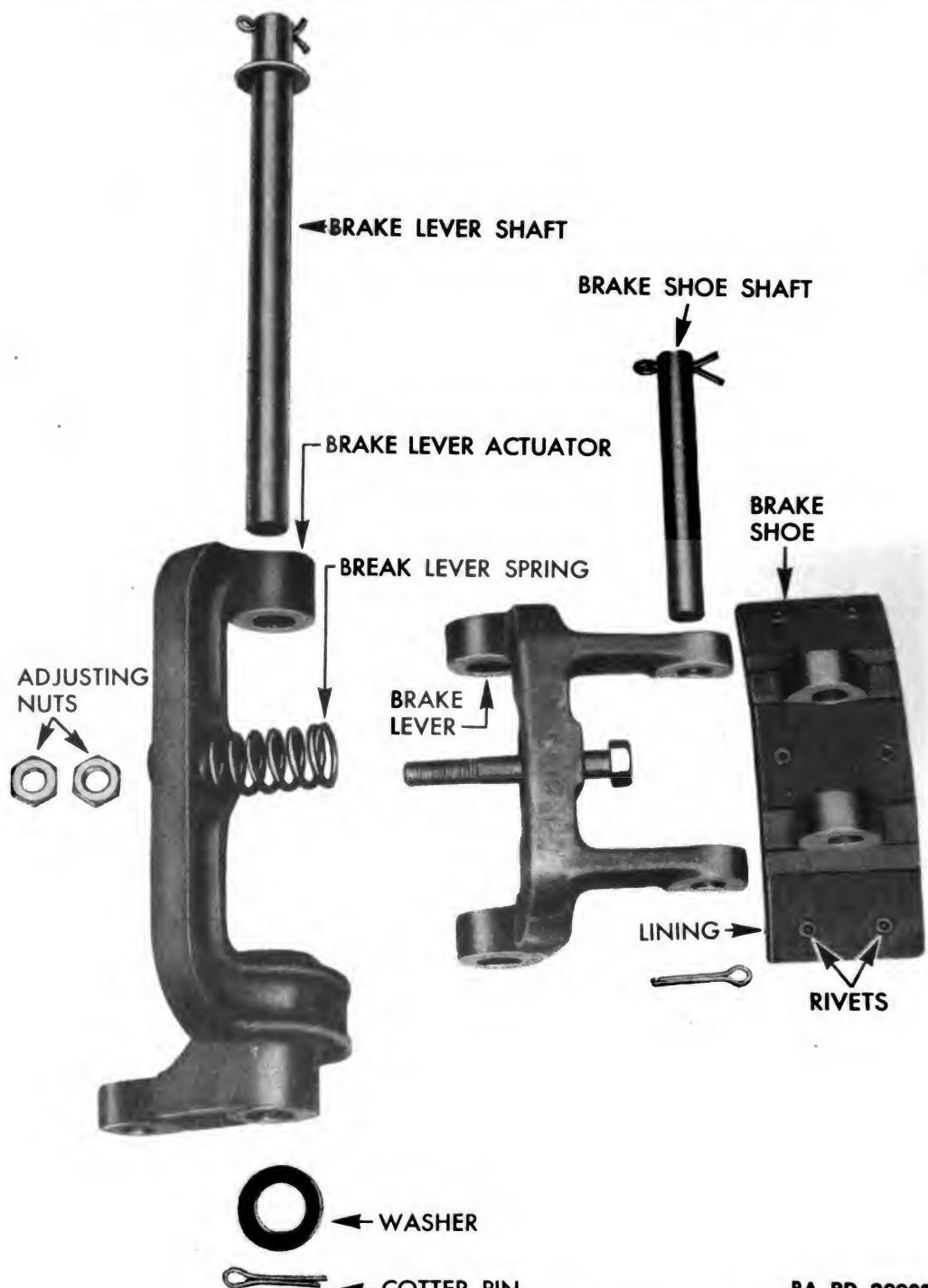
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Figure 175 — Clutch Brake Components

d. Clutch Brake Lever Spring. Inspect for weak or broken spring. Measure free length of spring. The free length dimension of a new spring is 2 to $2\frac{1}{16}$ inches. The test load of spring is 90 to 110 pounds at $1\frac{1}{4}$ inches. Replace broken or weak spring.

RA PD 20903

CLUTCH BRAKE

e. **Brake Shoe Assembly.** Inspect brake shoe for excessive wear, cracks, or breaks. If defective, replace with new part. Inspect brake lining for wear. If worn to rivet heads, reline brake shoe as described in subparagraph f following.

f. **Reline Clutch Brake Shoe.** Use a punch to drive out rivets, and remove old lining. Clamp new lining tightly in shoe with two C-clamps. Using $\frac{3}{16}$ -inch drill through the rivet holes, drill six holes. Remove lining from clamp and shoe, and counterbore holes to $\frac{3}{32}$ inch depth and $\frac{13}{32}$ inch diameter for rivet heads. Rivet lining to shoe, starting at center. Make sure lining is tight against shoe to prevent loosening of lining.

103. ASSEMBLY AND INSTALLATION.

a. **Install Brake Shoe** (fig. 174). Place brake shoe in position on brake lever, and attach with shaft and cotter pins.

b. **Install Clutch Brake Lever Spring** (fig. 175). Place cap screw through brake lever, brake lever spring, and brake lever actuator, and secure with two adjusting nuts.

c. **Install Clutch Brake** (fig. 174). Install brake lever and brake lever actuator in place on transmission input shaft rear bearing retainer, and insert brake lever shaft through brake lever, brake lever actuator, and bearing retainer. Secure shaft with plain washers and cotter pins. Connect clutch brake power cylinder to brake lever actuator, and attach with pin and cotter pin.

d. **Adjust Clutch Brake.** Refer to TM 9-786.

e. **Install Shell Box.** Refer to TM 9-786.

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CHAPTER 7 (Cont'd)

CLUTCH GROUP AND PROPELLER SHAFT
(Cont'd)

Section V

CLUTCH GEAR REDUCTION UNIT

	Paragraph
Description and operation	104
Removal	105
Disassembly	106
Cleaning, inspection, and repair (or rebuilding)	107
Assembly	108
Installation	109

104. DESCRIPTION AND OPERATION (figs. 137 and 138).

a. Description.

(1) The clutch gear reduction unit is located in the rear compartment of the engine clutch housing. It transmits power from the engine clutch to the propeller shaft. Working in conjunction with the two-way engine clutch, the unit provides a means of transmitting engine power, either direct to the transmission, or through a set of reduction gears. This provides a low and high-range for each transmission gear speed.

(2) The direct drive shaft, or high-range drive shaft, passes all the way through the clutch housing. It is mounted on two ball bearings; one in the engine flywheel, and one in a bearing cage at the front of the clutch housing.

(3) The low-range drive shaft is hollow, and rotates on the outside of the high-range drive shaft on one double-row type ball bearing and one single-row type ball bearing.

(4) The low-range idler gear is mounted on a stationary shaft in the lower section of the gear compartment of the clutch housing. The idler gear rotates on one single-row type ball bearing and one double-row type ball bearing.

(5) The clutch gear reduction unit operates in an oil bath which provides lubrication for all bearings and gears. The gear compartment of the clutch housing is provided with a coolant jacket on both sides and the bottom. Coolant is circulated through the jacket from the engine cooling system to maintain the clutch gear reduction unit lubricant at a uniform temperature. A drain valve is provided at the bottom of the coolant jacket to drain the engine cooling system. Three oil seals are provided to keep the lubricant in the clutch gear compartment; one around the clutch

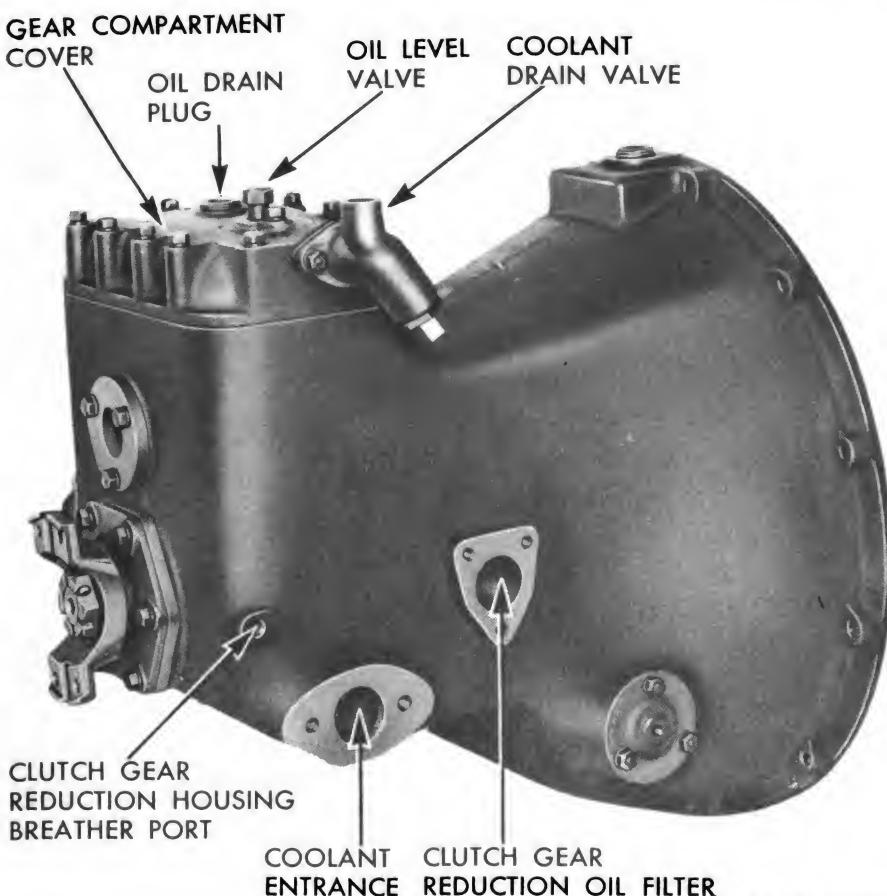
CLUTCH GEAR REDUCTION UNIT

and universal joint flange, one around the low-range drive shaft where it projects through the inside of the clutch housing, and one at the rear between the high and low-range drive shafts.

b. Operation.

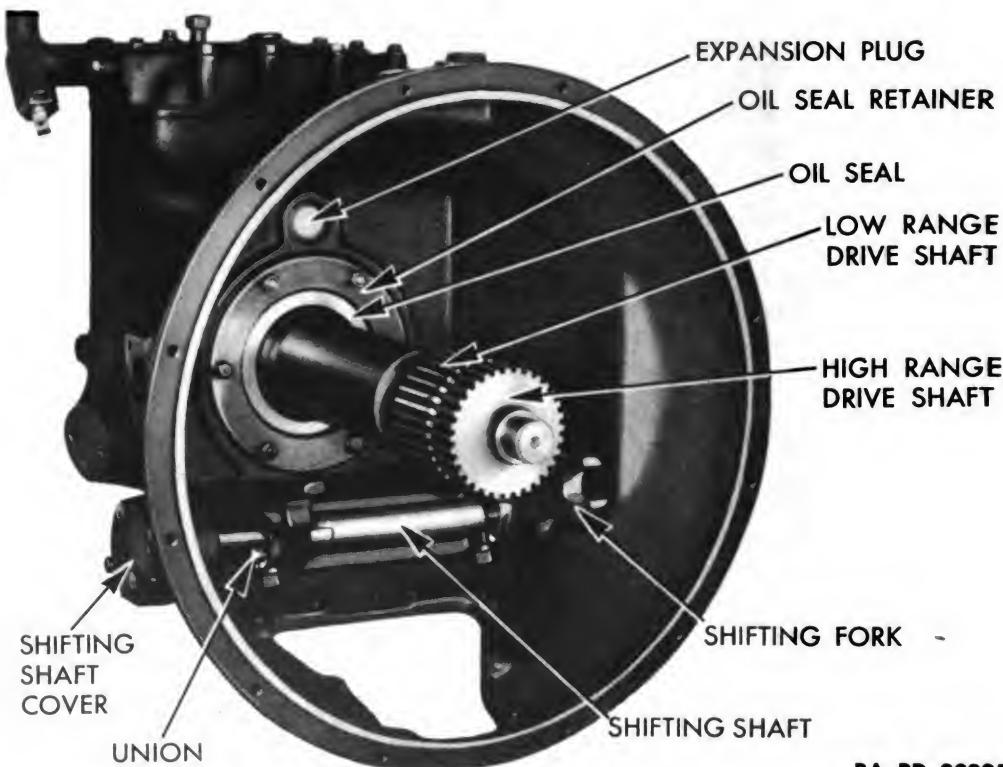
(1) HIGH-RANGE. The clutch driven plate, which is located between the engine flywheel and clutch pressure plate, is splined to the high-range drive shaft. When this driven plate is engaged between the engine flywheel and clutch pressure plate, engine power is transmitted straight through the high-range drive shaft to the propeller shaft. The low-range gear, low-range idler gear, low-range drive shaft, and second clutch driven plate are all rotating at the same time.

(2) LOW-RANGE. The clutch driven plate, which is located between the pressure plate and the back plate, is splined to the low-range drive shaft. When this driven plate is engaged between the clutch back plate and clutch pressure plate, engine power is transmitted through the low-range drive shaft, low-range idler gear, and low-range gear. The low-range gear is keyed to the high range drive shaft, which also serves as the output shaft. This line of power reduces the revolutions per minute of the propeller



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Figure 176 — Clutch Gear Reduction Unit with Bottom Side Up

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Figure 177 — Clutch Housing with Gear Reduction Unit Assembled

shaft with relation to the engine revolutions per minute. For example, if the engine speed is 1,000 revolutions per minute, the propeller shaft speed is 584 revolutions per minute.

(3) CLUTCH DISENGAGED. When the clutch is disengaged and the engine is running, the clutch rotates with the engine but the clutch driven plates remain stationary.

105. REMOVAL.

- Follow procedure outlined in paragraph 90.

106. DISASSEMBLY.

a. Drain Oil. Remove oil drain plug from clutch gear reduction cover, and allow oil to drain.

b. Remove Clutch Gear Compartment Cover (fig. 176). Place unit on wood blocks so that cover is face up. Remove 14 cap screws and lock washers attaching cover to clutch housing, and remove cover and gasket from housing.

c. Remove Low-Range Idler Gear Assembly (fig. 178). Remove three cap screws and lock washers attaching idler shaft to clutch housing. Install slide hammer type puller (41-P-2957-27) and final drive shaft pinion puller adapter (41-A-18-150) into

CLUTCH GEAR REDUCTION UNIT

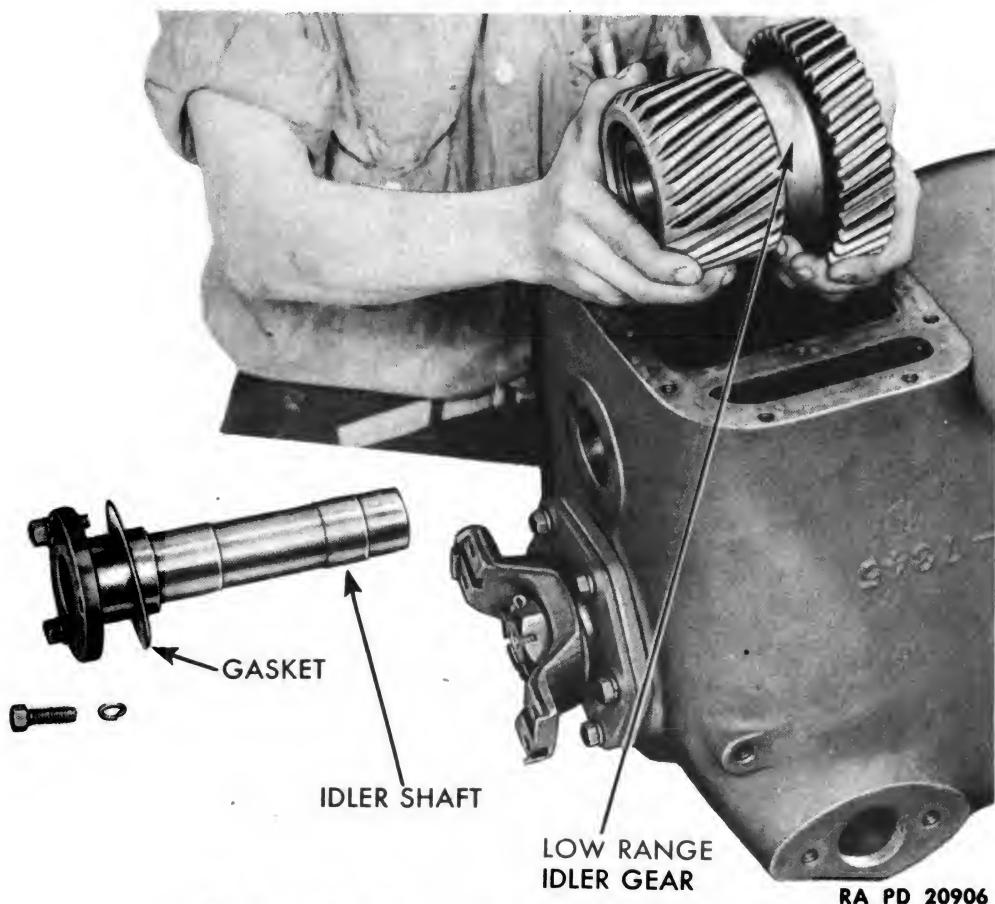


Figure 178 — Removing Low-Range Idler Gear

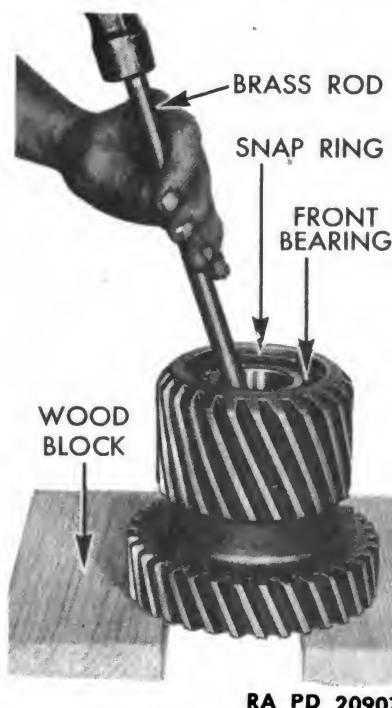
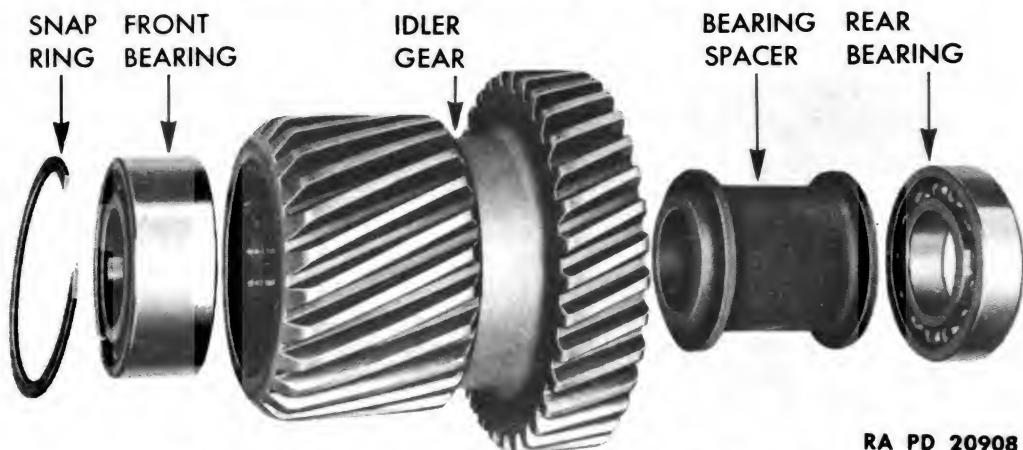


Figure 179 —
Removing
Idler Gear
Rear Bearing

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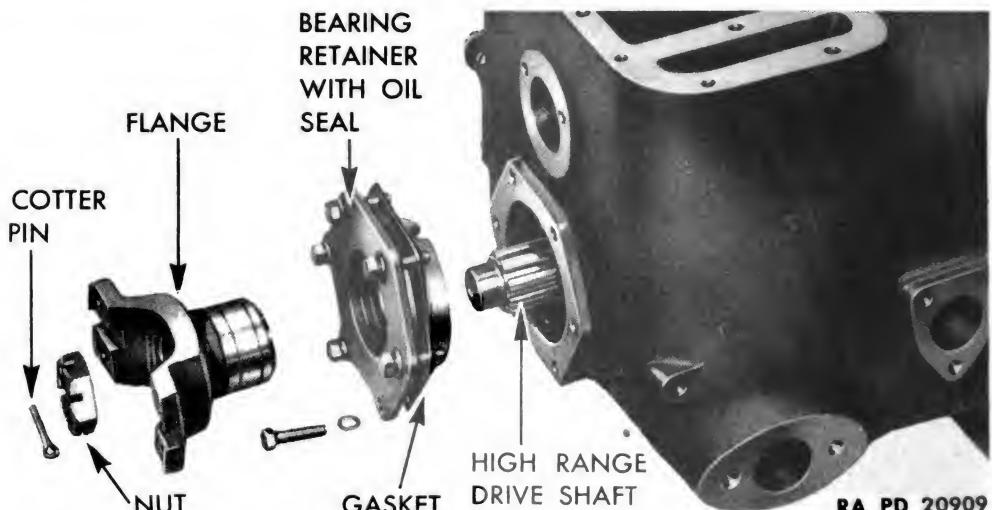
RA PD 20908

Figure 180 — Low-Range Idler Gear and Bearings

tapped hole in end of idler shaft, and pull idler shaft out of bearings in low-range idler gear and clutch housing. Remove low-range idler gear assembly from gear compartment in clutch housing.

d. Remove Bearings from Low-Range Idler Gear. With idler gear set on two wood blocks (fig. 179), use a brass rod and strike inner flange of bearing spacer to remove rear bearing from idler gear. Drive at different points on spacer to drive bearing out evenly. Leave bearing spacer in gear (fig. 180) to drive out front bearing. Remove snap ring, which retains front bearing in gear, and drive out front bearing.

e. Remove High and Low-Range Drive Shaft Assembly. Remove cotter pin and nut attaching universal joint flange to high-range drive shaft (fig. 181). Remove flange from spline of high-range drive shaft. Remove six cap screws and lock washers



RA PD 20909

Figure 181 — Universal Joint Flange and Bearing Retainer Removed

CLUTCH GEAR REDUCTION UNIT

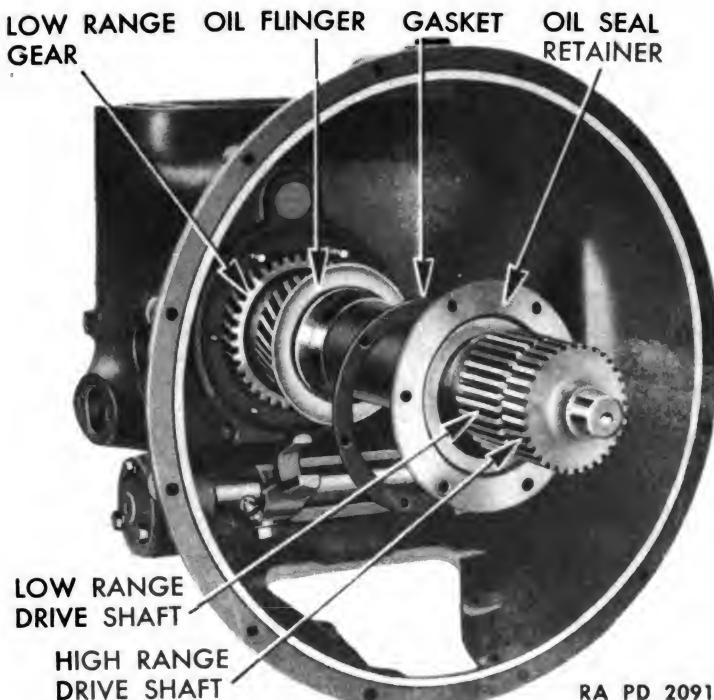


Figure 182 — High and Low-Range Drive Shafts Partially Removed

attaching front bearing retainer to clutch housing. Remove retainer and oil seal from housing and drive shaft. Remove four cap screws, two nuts, and six lock washers attaching inner oil seal retainer (fig. 177) to clutch housing. Supporting drive shaft assembly (fig. 182) at pilot bearing end, so that oil flinger will clear clutch housing, use soft hammer on front end of high-range drive shaft to drive the shaft from front bearing. Lift drive shaft assembly from clutch housing.

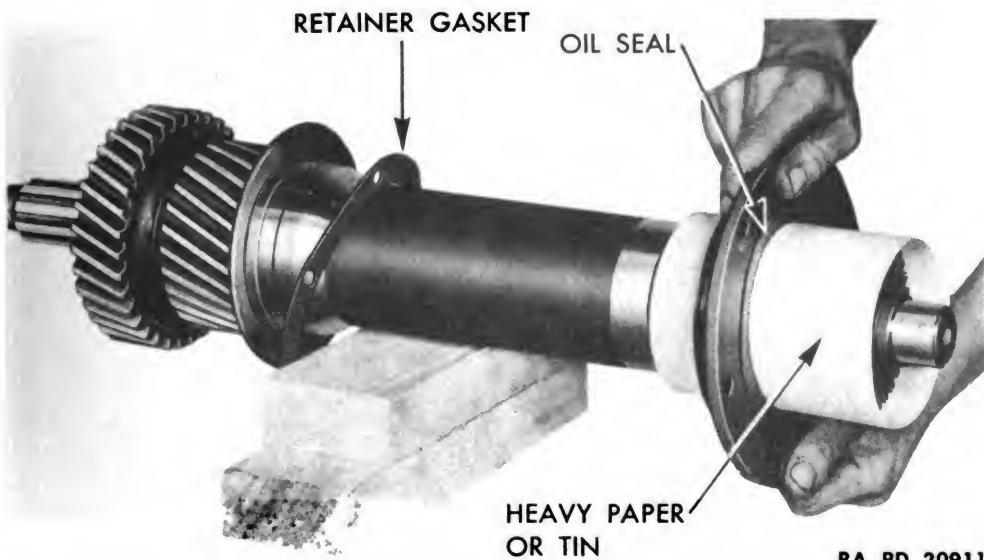
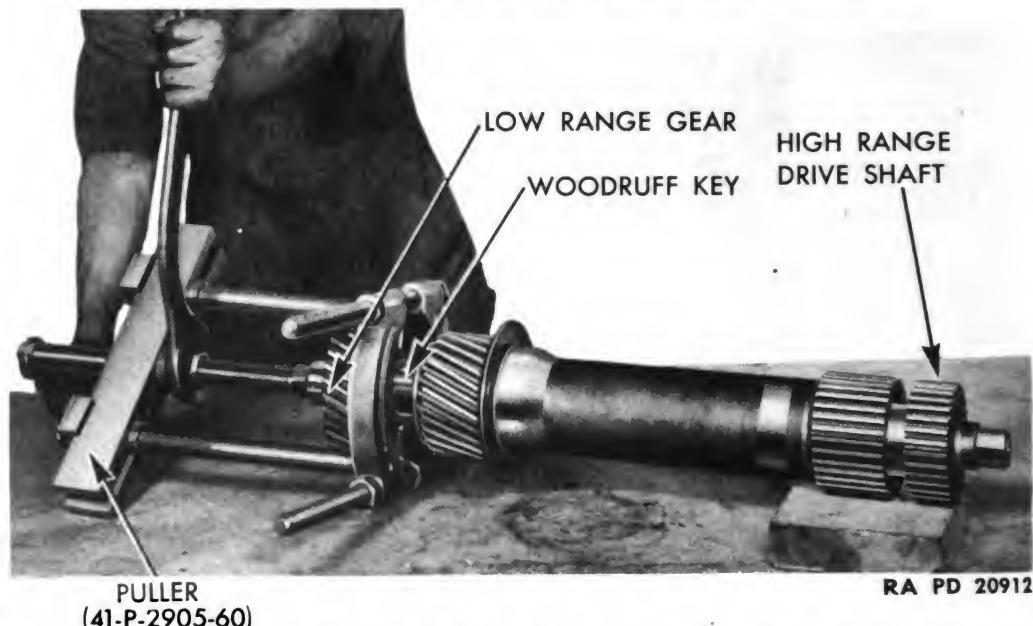


Figure 183 — Removing Oil Seal from Low and High-Range Drive Shafts

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**Figure 184 — Pulling Low-Range Gear from High-Range Drive Shaft,
Using Puller**



**Figure 185 —
Removing
High-Range
Drive Shaft
from
Low-Range
Drive Shaft**

RA PD 20913

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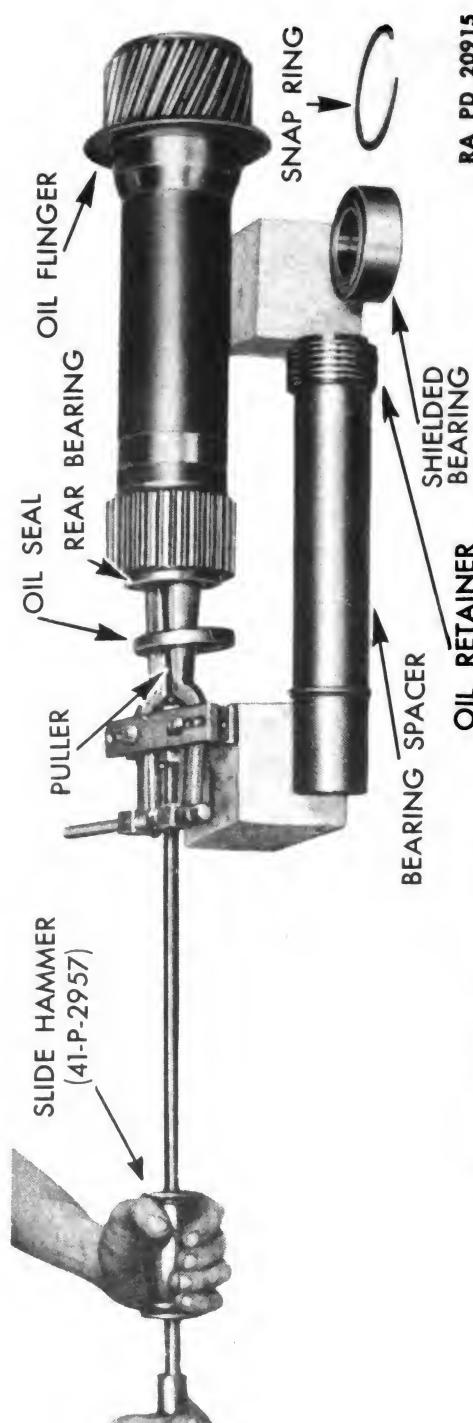
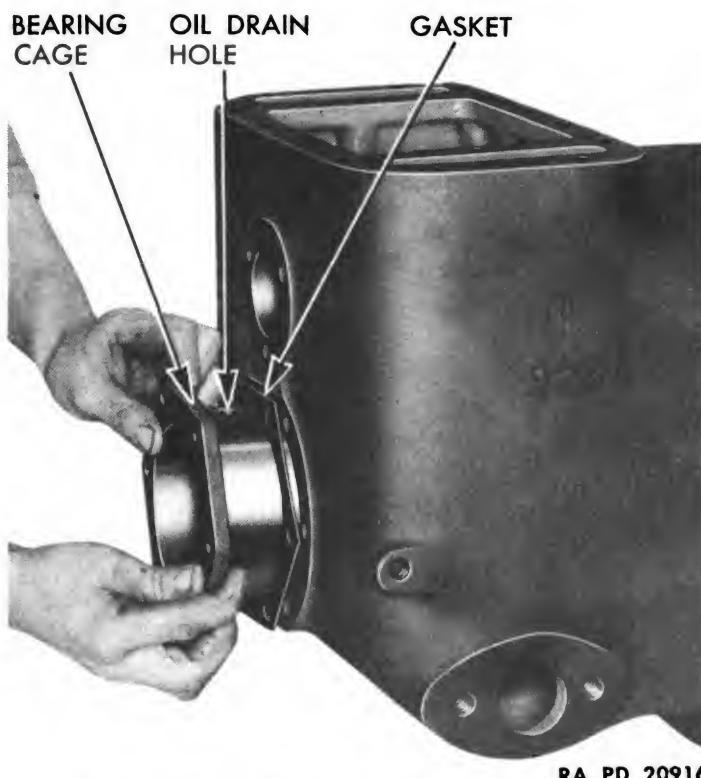


Figure 187 — Removing Rear Bearing from Drive Shaft, Using Puller

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f. **Disassemble High and Low-Range Drive Shaft Assembly.** Wrap a piece of heavy paper or a light piece of tin over drive teeth on low and high-range shafts, to prevent damage to lip of inner oil seal (fig. 183), and remove retainer and oil seal from drive shafts. Use a puller (41-P-2905-60) to remove low-range gear from high-range drive shaft (fig. 184). Remove Woodruff key from high-range drive shaft. Remove high-range drive shaft from bearings in low-range drive shaft by dropping threaded end of shaft on block of hard wood (fig. 185). Remove snap ring which retains intermediate shielded bearing in low-range drive shaft. Partially remove shielded bearing from inside of shaft by tapping end of low-range drive shaft on a block of hard wood. Install bearing puller (41-P-2906-15) (fig. 186), and remove intermediate shielded bearing from low-range drive shaft. Remove bearing spacer from drive shaft. Install bearing puller (41-P-2906-15) (fig. 187) in rear bearing, and pull oil seal and rear bearing from low-range drive shaft. If puller (41-P-2906-15) is not available the bearing can be removed by combining the jaws from puller (41-P-2905-60) and slide hammer from puller (41-9-2957) taking care to avoid damaging threads on slide hammer.



RA PD 20916

Figure 188 — Removing Front Bearing Cage

g. **Remove Front Bearing.** Remove front bearing cage (fig. 188) and gasket from front of clutch housing. Tap it with soft hammer if necessary. Remove front bearing from cage by tapping out with brass rod.

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Figure 189 — Coolant Drain Valve Disassembled

h. Remove and Disassemble Coolant Drain Valve Assembly.
Remove two cap screws and lock washers attaching drain valve to gear compartment cover. Remove packing gland and gasket from body. Screw valve with packing from body (fig. 189).
NOTE: *Do not remove packing from recessed portion of valve unless it requires replacement.*

i. Remove Clutch Shifting Shaft (fig. 177). Remove three cap screws and lock washers attaching shifting shaft cover to clutch housing, and remove cover and gasket. Remove two cap screws and lock washers clamping shifter fork to shaft. Drive shifting shaft from shifter fork, and remove two Woodruff keys from shaft. Remove shifting shaft from shifting fork and clutch housing.

**107. CLEANING, INSPECTION AND REPAIR
(OR REBUILDING).**

a. Clean.

(1) Clean all parts thoroughly with dry-cleaning solvent. Remove all gaskets, and clean surfaces where sealing compound has been used on clutch housing, retainers, and covers. Dry parts with compressed air.

(2) BEARINGS. After soaking thoroughly, bearings must be slushed up and down and spun slowly below surface of liquid to remove as much old grease as possible. Blow out bearings with compressed air, being careful to direct air pressure across bearings to remove last traces of old lubricant without spinning bearings. Inspect bearings immediately, as described in subparagraph **b** (4) below.

b. Inspect and Repair or Rebuild.

(1) **CLUTCH HOUSING ASSEMBLY.**

(a) *Clutch Housing.* Inspect housing for cracks, breaks, or other

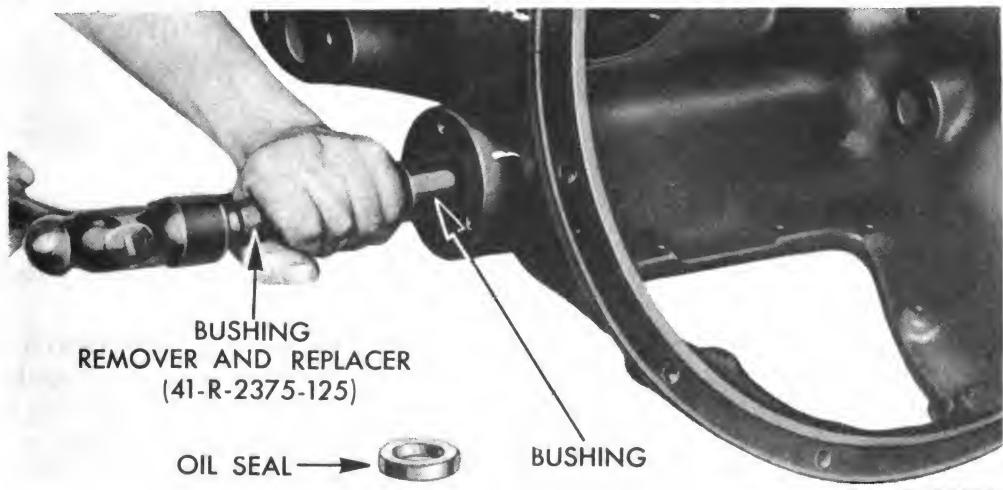
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damage. If badly cracked, broken, or damaged, replace housing. Small cracks or breaks may be repaired by welding. Inspect two studs inside of clutch housing for attaching inner oil seal retainer, to make sure they are tight in housing, and that threads are in good condition. If damaged, replace with new studs, and tighten so they extend out $\frac{1}{8}$ inch from machined surface in housing. Inspect all machined surfaces on covers, retainers, and clutch housing for nicks and burs which might cause water or oil leakage around gaskets. Remove any burs or nicks in machined surfaces with a fine file.



RA PD 20918

Figure 190 — Removing Shifting Shaft Bushing and Oil Seal, Using Brake Shaft Bearing Support Bushing Remover and Replacer



RA PD 20919

Figure 191 — Installing Shifting Shaft Bushing, Using Brake Shaft Bearing Support Bushing Remover and Replacer

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(b) *Clutch Shifting Shaft Bushings.* Inspect shifter shaft bushings for excessive wear. If worn excessively, replace bushings. The manufacturing tolerance of new bushings after pressing in place is 1.252 to 1.254 inches. Use brake shaft bearing support bushing remover and replacer (41-R-2375-125) to remove old bushings, and to install new shifting shaft bushings (figs. 190 and 191). Try clutch shifting shaft, and if it does not rotate freely, line-ream both bushings within the limits of the above dimensions.

(c) *Oil Seals.* Inspect each oil seal for excessive wear or damaged lips. Replace any seal that is damaged or excessively worn. Lip of seals must face toward outside of clutch housing.

(d) *Low-Range Idler Gear Expansion Plug.* Inspect idler gear expansion plug (fig. 177), to make sure the plug is tight and not leaking. If plug is leaking or loose, install a new plug, using sealing compound on plug and on groove in plug hole.

(e) *Shifter Fork.* Inspect shifter fork for wear, cracks, or breaks. If fork is worn or broken, replace with new one.

(2) **HIGH AND LOW-RANGE DRIVE SHAFTS, AND LOW-RANGE IDLER SHAFT.** Inspect teeth on high and low-range drive shafts for wear, chipping, nicks, or roughness. Nicks or roughness can be removed with an oil stone. Worn shafts must be replaced. Using a new clutch driven plate hub as a gage, check to see that it slides freely back and forth on the splines of both shafts. If clutch plate hub binds in splines, and the cause of binding cannot be remedied, replace shaft. A new clutch driven plate hub and drive shaft have 0.003 to 0.005-inch backlash. If inner races of bearings have been rotating on high-range drive shaft or low-range idler shaft, replace shaft. Inspect shafts for twisting or bending. Place high-range drive shaft between centers in lathe, and check with a dial indicator. On a new shaft all outside diameters must be concentric with the center line. Assemble low-range shaft and bearings with high-range shaft, and check low-range shaft with dial indicator. If oil slinger is loose on low-range drive shaft, install a new one. If a low-range drive shaft is replaced, install new oil slinger.

(3) **GEARS.** Inspect gear teeth for wear and chipping. Replace gears if damaged.

(4) **BEARINGS.** Inspect balls and races carefully for chipping, cracks, or worn spots. Replace bearings with new ones if they are damaged or worn. Lubricate bearings with light oil, and wrap them with paper until ready for assembly.

(5) **OIL SEALS.** Inspect high-range drive shaft front bearing retainer oil seal, and low-range drive shaft front and rear oil seals, for worn or damaged lips. Replace if found to be defective. Before assembling oil seals, they should be soaked in light oil until the lips are soft. Using input shaft oil seal replacer (41-R-2392-885), and $\frac{3}{4}$ -inch handle for removers and replacers (41-H-1395-988), drive oil seal into high-range shaft front bearing retainer. Using final drive shaft oil seal replacer (41-R-2392-545),

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Figure 192 — Installing Low Range Drive Shaft Inner Oil Seal in Retainer with Final Drive Shaft Oil Seal Replacer

drive oil seal into low-range drive shaft inner oil seal retainer, with lip against shoulder in retainer (fig. 192).

(6) UNIVERSAL JOINT FLANGE. Inspect splines and keyways for attaching universal joint trunnion bearings, and replace flange if excessively worn, chipped, or broken. Check to see that splines of flange are tight on splines of high range drive shaft. Replace flange if splines have backlash.

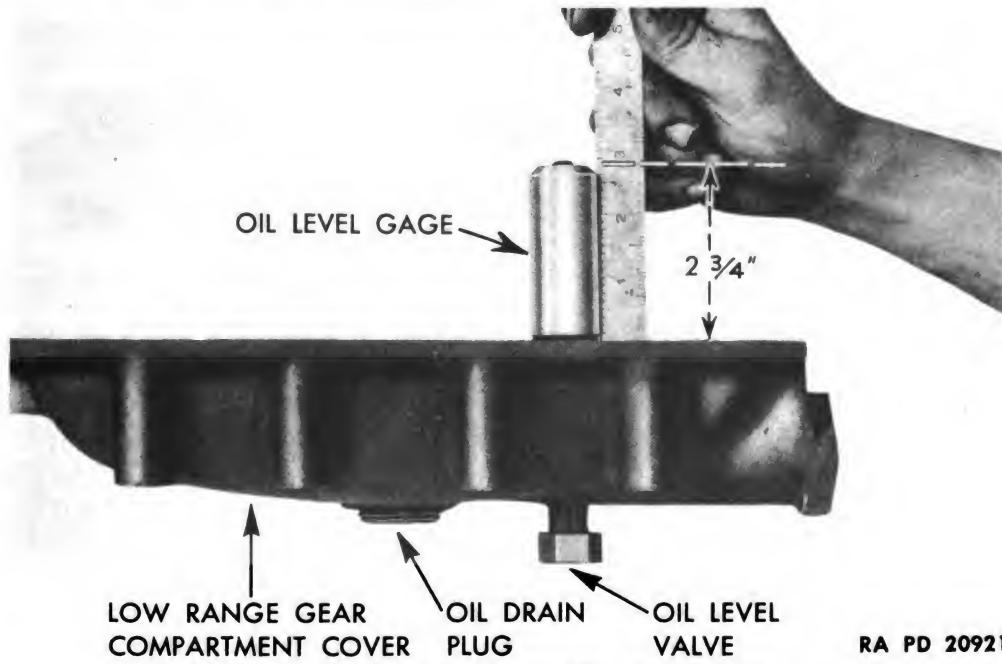


Figure 193 — Checking Oil Level Gage

(7) CLUTCH GEAR REDUCTION UNIT OIL LEVEL GAGE (fig. 193). Inspect oil level gage to make sure it is tight and securely staked or welded to cover, and that it extends $2\frac{3}{4}$ inches above machined surface on clutch gear reduction compartment cover. NOTE: On vehicles with serial No. 818 and above, the gage will be welded

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to cover. If it is evident that gage has been loosened from cover while tightening valve, gage must be tightened to dimension given above, and staked or welded into position. Inspect seats of valve and gage for scoring or signs of oil leakage, and if defective, replace valve and gage (or cover with gage).

(8) CLUTCH GEAR REDUCTION COOLANT DRAIN VALVE ASSEM-BLY. Inspect drain valve and drain valve body for scoring, or signs of coolant leakage. If defective, replace with new assembly. Inspect condition of packing. If worn or damaged, replace with new packing.

108. ASSEMBLY.

a. **Preparation.** Lubricate bearings with light oil, and soak oil seals until leather is soft. Be sure all parts are kept clean.

b. **Install Bearings and Oil Seal in Low Range Drive Shaft.** Press rear bearing, then oil seal, into position in low range drive shaft. Lip of oil seal must face toward inside of shaft. Install bearing spacer, with oil retainer toward front end of shaft. Press intermediate shielded bearing in front end of low-range drive shaft, with shielded side of bearing facing out, and install snap ring in groove in drive shaft.



RA PD 20922

Figure 194 — Replacing Low-Range Gear with Bearing and Universal Joint Flange Clutch Low-Range Gear Replacer

c. **Install High-Range Drive Shaft.** Push high-range drive shaft into low-range drive shaft through oil seal and bearings. Install Woodruff key in high-range drive shaft. With bearing and universal joint flange clutch low-range gear replacer (41-R-2383-785), drive low-range gear into place on high-range drive shaft (fig. 194).

d. **Install High and Low-Range Drive Shaft Assembly.** Press high-range drive shaft front bearing into bearing cage, making sure the bearing and other units are kept clean. Shellac new gasket in position, and set bearing cage in place in front of clutch housing, lining up oil drain hole in bearing cage with hole in clutch housing (fig. 188). Shellac new gasket on front bearing retainer with oil seal, and install it in bearing cage. Attach retainer and bearing cage with six cap screws and lock washers to

CLUTCH GEAR REDUCTION UNIT

clutch housing so that slot in retainer and hole in bearing cage line up with oil hole in clutch housing. Place splined end of drive shaft assembly through low-range gear compartment and front bearing. Supporting the pilot bearing end of shaft assembly to prevent damage to oil flinger, drive the shaft into position in front bearing. Using heavy paper, or light piece of tin, to protect oil seal, slide inner oil seal retainer with new gasket over gear end of drive shafts (fig. 183). Attach inner oil seal retainer to clutch housing with four cap screws, two nuts, and six lock washers. Lubricate splines on front of high-range drive shaft, and install flange on drive shaft. Attach flange with nut and cotter pin.

e. **Install Low-Range Idler Gear.** Press or drive single-row ball bearing into large hole in end of idler gear. Place bearing spacer in other end of idler gear, and press double-row ball bearing into gear. Install snap ring in groove of gear. Place idler gear in position inside of clutch gear compartment. Shellac new gasket to flange on idler shaft, and install idler shaft through clutch housing and idler gear. Secure shaft flange to housing with three cap screws and lock washers.

f. **Install Clutch Gear Compartment Cover.** Shellac new gasket on cover, and secure cover to housing with 14 cap screws and lock washers.

g. **Install Coolant Drain Valve Assembly.** Screw valve into body until seated (fig. 189). Install gasket on packing gland, and screw gland into body. Shellac new gasket on drain valve body, and attach valve assembly to gear compartment cover with two cap screws and lock washers.

h. **Install Clutch Shifting Shaft and Fork** (fig. 177). Place shifter fork in position in clutch housing, and slide shifting shaft through clutch housing and shifter fork. Oil hole in end of shaft must be installed toward shifting shaft cover side of housing. Place two Woodruff keys in slots in shaft. Drive the shaft with Woodruff keys into shifter fork. Install clutch release yoke grease tube union in shifting shaft. Check to see that end of shifting shaft is flush with boss on clutch housing for attaching shifting shaft cover. If end of shaft is not flush with boss, tap it in or out with soft hammer. Install and tighten two cap screws and lock washers clamping fork to shifting shaft. Shellac new gasket on shifting shaft cover, and attach cover to clutch housing with three cap screws and lock washers.

109. INSTALLATION.

a. Refer to paragraph 94.

CHAPTER 7 (Cont'd)

CLUTCH GROUP AND PROPELLER SHAFT (Cont'd)

Section VI

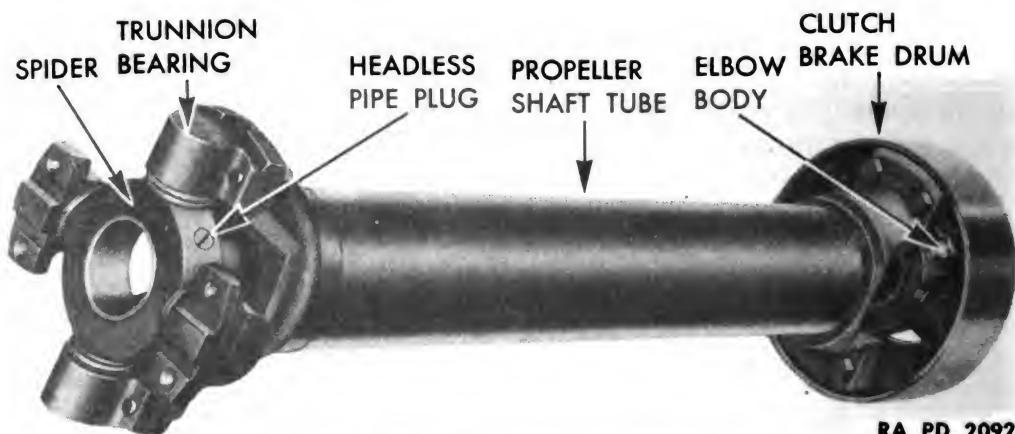
PROPELLER SHAFT

	Paragraph
Description	110
Disassembly	111
Cleaning, inspection, and repair (or rebuilding)	112
Assembly	113

110. DESCRIPTION (fig. 195)

a. The propeller shaft assembly transmits power from the clutch to the transmission. It consists of a tubular shaft and two universal joints with flanges. The propeller shaft is a hollow welded-steel tube with a flange welded to each end. The universal joints consist of a universal joint spider assembly mounted between two flanges by means of four trunnion bearings. The universal joint flange on the clutch high range drive shaft is attached with a nut and cotter pin. The yoke on the transmission input shaft, which is welded to the clutch brake drum, is free to move back and forth on the splines of the input shaft.

b. Removal and installation of the propeller shaft are described in TM 9-786.



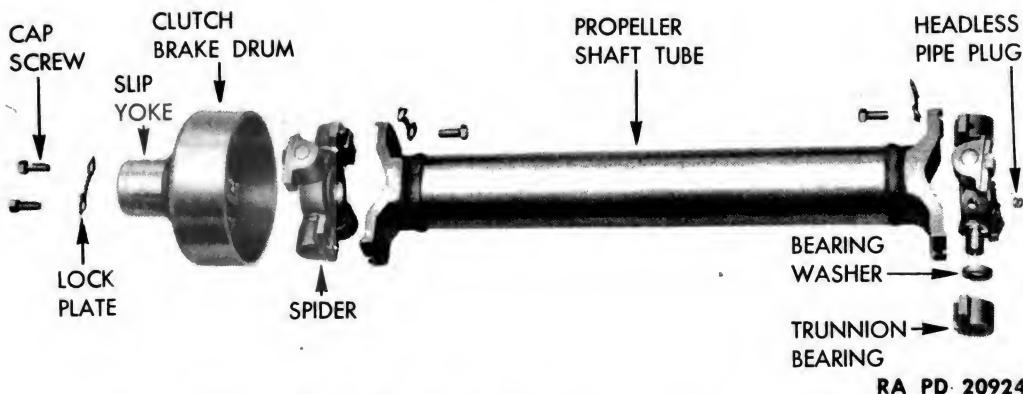
RA PD 20923

Figure 195 — Propeller Shaft with Universal Joints Assembly

111. DISASSEMBLY (fig. 196)

a. Remove two cap screws and one lock plate attaching each of

PROPELLER SHAFT



RA PD 20924

Figure 196 — Propeller Shaft with Universal Joints Components

two trunnion bearings to brake drum, and each of four trunnion bearings to propeller shaft tube flanges. Remove four trunnion bearings from each of two spiders. NOTE: *Be very careful not to lose any of the needle bearings from trunnion bearing assemblies.* Remove trunnion bearing washer (cork) from retainer in trunnion bearing. Remove one headless pipe plug and elbow body from one universal joint spider, and one headless pipe plug from the other universal joint spider.

112. CLEANING, INSPECTION AND REPAIR (OR REBUILDING).

a. **Clean.** Wash propeller shaft and universal joint parts thoroughly with dry-cleaning solvent, and dry with compressed air. Thoroughly clean oil passages in universal joint spiders.

b. Inspect and Repair or Rebuild.

(1) **BRAKE DRUM WITH YOKE ASSEMBLY.** Inspect yoke oil seal surface for roughness which might cause oil leakage. Check splines for excessive wear, cracks, or breaks; replace if excessively worn, cracked, or broken. Check break drum for roughness or scoring. If scored, place in lathe and smooth the surface. Inspect plug to see that it is staked securely in end of splineway, and that there is no evidence of oil leaking around edge.

(2) **TRUNNION BEARING ASSEMBLY.** Inspect bearings for excessive wear by trying them on spider bearing surface and in flange keyways. If defective, replace.

(3) **PROPELLER SHAFT TUBE.** Inspect propeller shaft tube for damage, excessive wear of keyway in flanges, cracks, and breaks. If damaged, cracked, or broken, replace propeller shaft.

(4) **SPIDER.** Inspect spider bearing surfaces for excessive wear, damaged dust shield, cracks, or breaks. Dust shields must be tight on spider. Replace if defective. Be sure all oil passages to trunnion bearings are open to provide adequate lubrication to bearings.

**ORDNANCE MAINTENANCE — ENGINE, ENGINE ACCESSORIES, CLUTCH GROUP,
AND PROPELLER SHAFT FOR 13-TON, HIGH-SPEED TRACTOR M5**

113. ASSEMBLY.

a. Assemble Propeller Shaft and Universal Joints. Place a liberal coating of grease on 22 needle bearings in each of the 8 trunnion bearing assemblies. Place eight new trunnion bearing washers (cork) in retainers of trunnion bearings, and place trunnion bearings in position on two universal joint spiders. Place spiders, with bearings in place, on propeller shaft, and attach each with four cap screws and two lock plates. Tie other two trunnion bearings in place on rear spider to prevent loss. Screw lubricating fitting elbow body into front spider. Place brake drum in position on two trunnion bearings on front spider, and attach with four cap screws and two lock plates.

b. Lubricate Universal Joints. Refer to TM 9-786. After lubricating, place headless pipe plugs in spider and in elbow body.

CHAPTER 7 (Cont'd)**CLUTCH GROUP AND PROPELLER SHAFT
(Cont'd)****Section VII****FITS AND TOLERANCES**

	Paragraph
Clutch	114
Clutch controls	115
Clutch gear reduction unit	116
Clutch brake	117

114. CLUTCH.**a. Driven Plate.**

Number of plates	2
Facing O.D.	15 $\frac{7}{8}$ in.
Facing I.D.	9 in.
Thickness of disk facing	0.340 to 0.345 in.
Facing area (one side)	135 sq in.
Facing must be parallel and flat within	0.010 in.
Driven plate maximum allowable run-out	0.010 in.
New driven plate clearance, clutch in neutral position	0.040 in.
Maximum allowable wear	0.085 in.
Neutral position distance from stop clamp to release sleeve	1.200 in.

b. Pressure Plate.

Thickness of pressure plate	1.080 to 1.082 in.
Width of back plate drive stud slots	1.248 to 1.251 in.
Plate balanced within	0.5 in.-oz

c. Pressure Ring, and Inner and Outer Actuating Rings.

Ground surfaces between each ring must be flat within 0.005 in.

d. Back Plate and Driving Stud Assembly.

Quill must be concentric with pilot diameter within	0.005 in.
Driving stud width	1.233 to 1.235 in.

e. Pressure Springs.

Free length	$2\frac{3}{16}$ in.
Test load at $1\frac{3}{16}$ in.	273 to 301 lb

f. Pressure Plate Equalizer Springs.

Free length	$1\frac{1}{8}$ in.
-----------------------	--------------------

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Test load at $1\frac{5}{16}$ in. 36-44 lb

115. CLUTCH CONTROLS.

a. Clutch Pedal Bushings.

Inside diameter (pressed in pedal) 1.1251 to 1.1268 in.
Diameter of clutch pedal shaft 1.122 to 1.125 in.

b. Service Clutch Pedal Return Spring.

Free length center to center of anchor pin holes $8\frac{5}{32}$ in.
Test load at $9\frac{5}{8}$ inches 92 to 112 lb

c. Emergency Clutch Pedal Return Spring.

Free length $5\frac{1}{2}$ in.
Test load at $8\frac{1}{2}$ in. 25 to 30 lb

d. Clutch Pedal Bumper Spring.

Test load at $2\frac{5}{8}$ in. 144 to 158 lb

e. Clutch Selector Housing Bushings.

Two larger bushings, inside diameter
pressed in place 1.0625 to 1.0655 in.

Four smaller bushings, inside diameter
pressed in place 0.7505 to 0.7535 in.

f. Clutch Selector Shifter Rod Poppet Spring.

Free length $2\frac{27}{32}$ in.
Test load at $2\frac{1}{2}$ in. 9 to 11 lb

g. Clutch Selector Toggle Over-Center Springs.

Free length $4\frac{31}{32}$ in.
Test load at $5\frac{5}{8}$ in. 32 to 39 lb

h. Clutch Power Cylinder Lever Bushings.

Inside diameter (pressed in lever) 1.0020 to 1.0025 in.

116. CLUTCH GEAR REDUCTION UNIT.

a. Clutch Shifting Shaft Bushings.

Inside diameter (pressed in place)
(line-ream if necessary) 1.252 to 1.254 in.
Diameter of shifting shaft 1.247 to 1.250 in.

FITS AND TOLERANCES

b. High and Low-range Drive Shafts.

Backlash between teeth of drive shaft
and driven plate 0.001 to 0.005 in.

c. Gears.

Backlash between all mating gear teeth 0.006 to 0.008 in.

117. CLUTCH BRAKE.

a. Clutch Brake Lever Spring.

Free length $2\frac{1}{16}$ in.
Test load at $1\frac{1}{4}$ inches 90 to 110 lb

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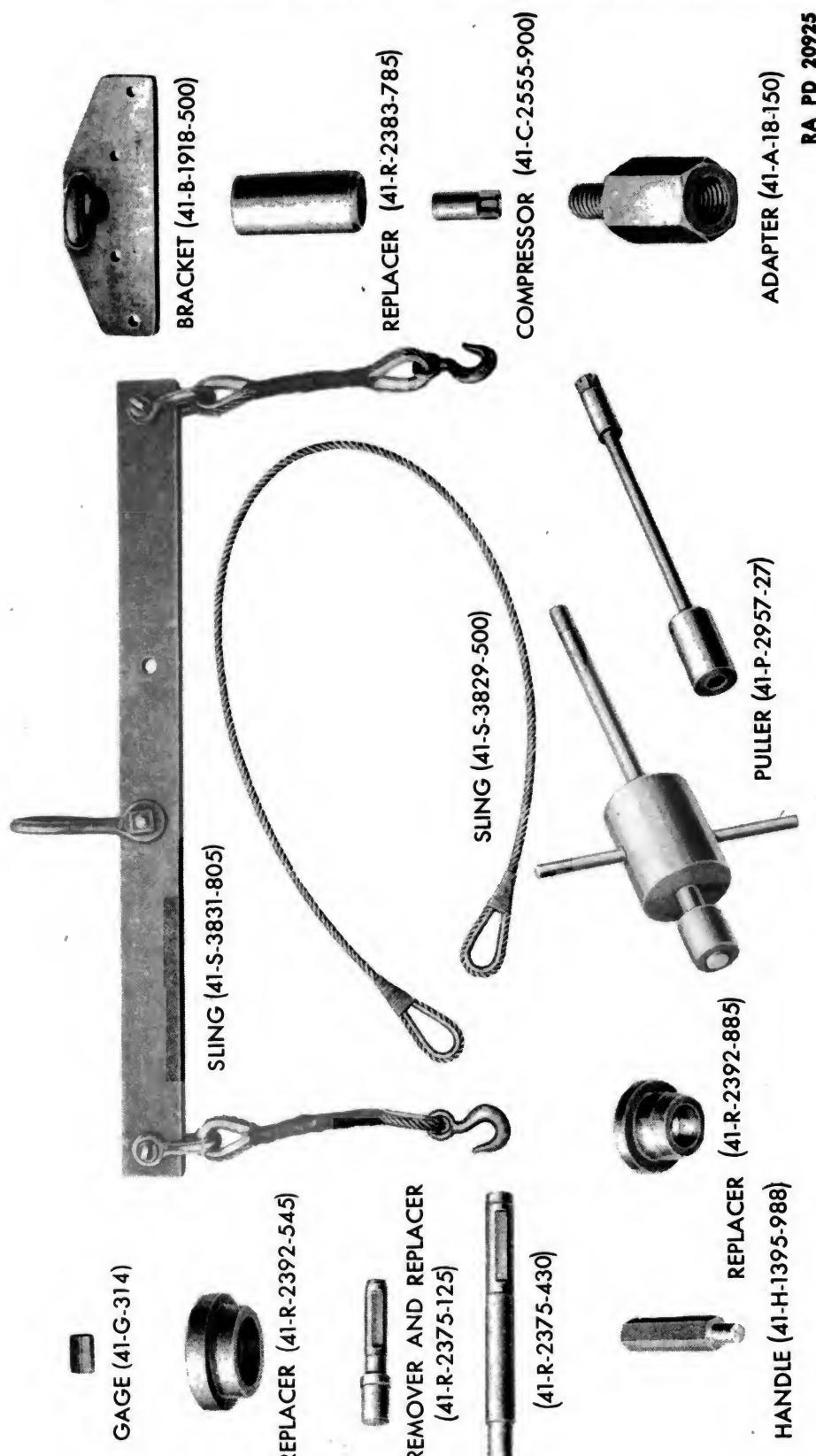


Figure 197 — Special Tools

RA PD 20925

SPECIAL TOOLS

CHAPTER 8
SPECIAL TOOLS

List of special tools.....

118. LIST OF SPECIAL TOOLS.

SPECIAL TOOLS	MANUFACTURER'S NUMBER	FEDERAL STOCK NUMBER	ORDNANCE DRAWING NUMBER	ECHELONS					Paragraph
				1	2	2	2	5	
ADAPTER, puller, final drive shaft pinion (used with puller (41-P-2957-27).....	MAS-7-416	41-A-18-150	A386578	..	..	1	1	1	1
BRACKET, clutch lifting.....	MAS-7-216	41-B-1918-500	C102929	..	..	..	1	1	1
COMPRESSOR, spring and U-washers, clutch equalizer.....	MAS-7-211	41-C-2555-900	A386394	..	..	1	1	1	1
GAGE, setting, clutch plate clearance	MAS-7-217	41-G-314	C102930	..	..	..	1	1	1
HANDLE, remover and replacer (3 $\frac{1}{4}$ in.).....			41-H-1395-988	A411984	..	..	1	1	1
Base Shop Set									
4th Ech. set for Hwy. Maint. Comd. Shops				4					
Co., or Post Shops				3					
Mdm. & Hwy. Maint. Regt. or Plt. Set				2					
3rd Ech. set for Ltr. Maint. Regt. or Plt. Set				2					
Crew Set				2					
Company Set				2					
Vehicle Set				1					

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SPECIAL TOOLS	SPECIAL TOOL DESCRIPTION	MANUFACTURER'S NUMBER	FEDERAL STOCK NUMBER	ORDNANCE DRAWING NUMBER	ECHELONS				
					1	2	2	2	5
PULLER, slide hammer type	41-P-2957-27	C66644							
REMOVER and REPLACER, brake shaft bearing support bushing	41-R-2375-125	B298849							
REMOVER and REPLACER, differential and final drive housing cover steering lever bushing	41-R-2375-430	B298848							
REPLACER, bearing and universal joint flange clutch low range gear	41-R-2383-785	B298832							
REPLACER, oil seal, final drive shaft	MAS-7-405	41-R-2392-545	B298847						
REPLACER, oil seal, input shaft	MAS-7-304	41-R-2392-885	B298940						
SLING, clutch lifting	KRW-M8-2328	41-S-3829-500	B295880						
SLING, engine lifting	MAS-7-122	41-S-3831-805	D75361						

REFERENCES

STANDARD NOMENCLATURE LISTS.

Tractor, high-speed, 13-ton, M5 (International Harvester)	SNL G-162
Cleaning, preserving, and lubrication materials, recoil fluids, special oils, and miscellaneous related items	SNL K-1
General tools and supplies, ordnance base automotive maintenance (engine rebuild)	SNL N-327
General tools and supplies, Ordnance base depot company	SNL N-377
Ordnance maintenance sets	SNL N-21
Soldering, brazing and welding material, gases and related items	SNL K-2
Tools, maintenance, for repair of automotive vehicles	SNL G-27
Interchangeability chart of ordnance maintenance tools for combat vehicles	Vol. I SNL G-27 Vol. II
Tool-sets, for ordnance service command, automotive shops	SNL N-30
Tool-sets, motor transport	SNL N-19
Current Standard Nomenclature Lists are listed above. An up-to-date list of SNL's and other publications is maintained in the Index to Ordnance Publications	OFSB 1-1

EXPLANATORY PUBLICATIONS.

General.

List of publications for training	FM 21-6
Military motor vehicles	AR 850-15
Standard military motor vehicles	TM 9-2800

Related Technical Manuals.

13-Ton high-speed tractor M5 (International Harvester)	TM 9-786
Ordnance Maintenance: Carburetors (Zenith)	TM 9-1826C
Ordnance Maintenance: Electrical equipment (Delco-Remy)	TM 9-1825A
Ordnance Maintenance: Fuel pumps	TM 9-1828A
Ordnance Maintenance: Power train, track, suspension, and equipment for 13-ton high-speed tractor M5 (International Harvester)	TM 9-1786B

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Ordnance Maintenance: Speedometers and tachometers (Stewart Warner) TM 9-1829A

Maintenance and Repair.

Automotive electricity	TM 10-580
Automotive lubrication	TM 10-540
Basic maintenance manual	TM 38-250
Cleaning, preserving, lubricating, and welding materials and similar items issued by the Ordnance Department	TM 9-850
Electrical fundamentals	TM 1-455
Fuels and carburetion	TM 10-550
Instruction guide: Welding—theory and application	TM 9-2852
Motor transport	FM 25-10
Motor vehicle inspections and preventive maintenance services	TM 9-2810
The internal combustion engine	TM 10-570
The motor vehicle	TM 10-510

Protection of Material.

Camouflage	FM 5-20
Chemical decontamination materials and equipment	TM 3-220
Decontamination of armored force vehicles	FM 17-59
Defense against chemical attack	FM 21-40
Explosives and demolitions	FM 5-25
Military chemistry and chemical agents	TM 3-215

Storage and Shipment.

Registration of motor vehicles	AR 850-10
Storage of motor vehicle equipment	AR 850-18
Ordnance storage and shipment chart, Group G—Major Items	OSSC-G
Rules governing the loading of mechanized and motorized army equipment, also major caliber guns, for the United States Army and Navy, on open top equipment, published by Operations and maintenance Department of Association of American Railroads.	

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